APPENDIX B

Origin-Destination Study

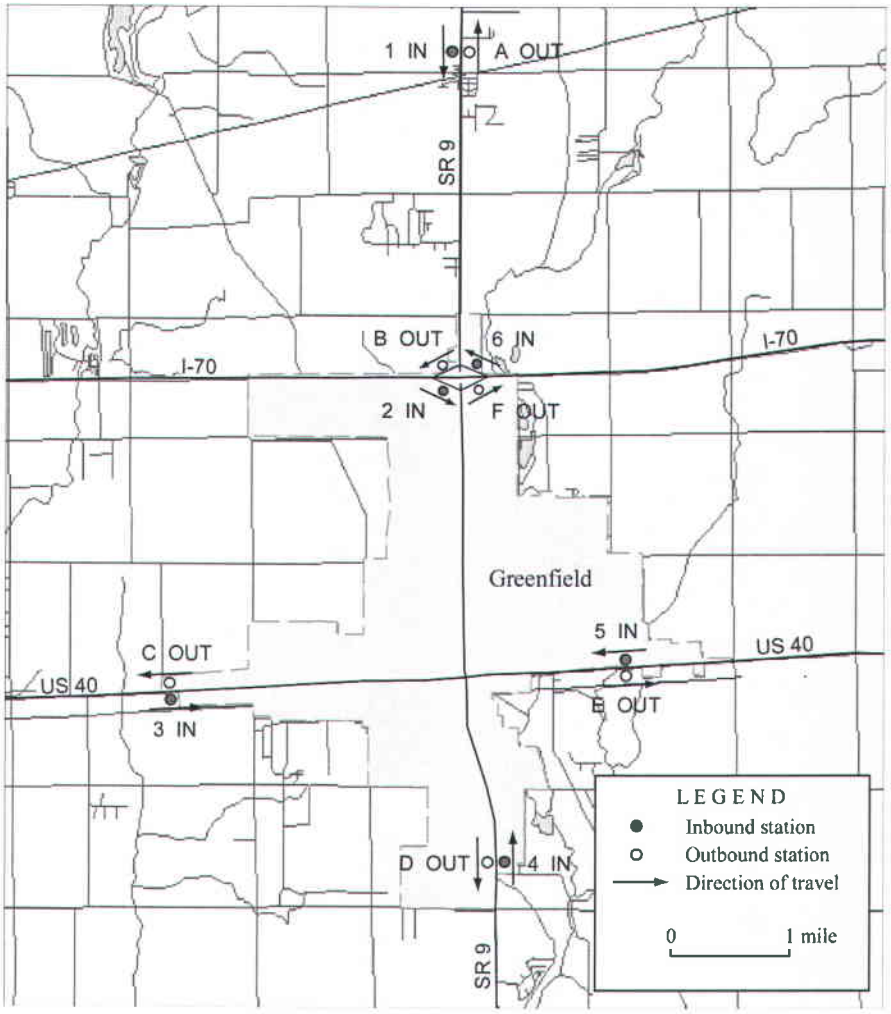
APPENDIX B : ORIGIN – DESTINATION STUDY

DATA COLLECTION

Existing weekday through trip data were collected through a cooperative effort by Paul I. Cripe Inc. (PIC) and Pflum, Klausmeier & Gehrum Consultants, Inc. (PKG) to conduct a manual license plate survey at twelve one-directional observation points on the periphery of the SR 9 arterial corridor serving the City of Greenfield.

Figure A.01 shows the location of the survey stations. As indicated on the map, stations designated 1 through 6 carry traffic into the Greenfield study area; stations designated A through F carry traffic away from the study area.

FIGURE A.01 : License Plate Survey Stations



Continuous and coordinated license plate data were recorded during three 2.5-hour periods on Wednesday, August 22, 2001. During two periods of peak local traffic volumes, 6:00 AM to 8:30 AM and 3:30 PM to 6:00 PM, observers sequentially recorded all legible license plates of passenger vehicles and tallied the number of heavy vehicles, whether trucks or busses. A third midday observation period from 11:00 AM to 1:30 PM was used for recording license plates of heavy vehicles only. Anticipated difficulty in reading the license plates of heavy vehicles during periods of low-angle sunlight and high traffic volumes was the primary reason for restricting recording of these vehicles to the midday off-peak period.

Using voice recorders, observers verbally recorded the last four license plate characters of each passing vehicle. On the afternoon of the day preceding the survey, observers were briefed on the variety of license plate types to anticipate, including a uniform procedure for reporting plates with less than four digits. Using synchronized watches, observers also reported times of day within the stream of license plate data at fifteen-minute intervals.

Survey personnel were instructed to record entries of "T" (truck) or "B" (bus) for heavy vehicles because of the perceived difficulty in identifying and reading license plates of such vehicles when interspersed in high volumes of traffic. The survey processing procedure acknowledges that these data are invalid for the purpose of determining matches within sequential data streams and requires such records to be deleted after being tabulated.

All audio recording cassettes were labeled with location, observation period, and sequence of use information.

DATA PREPROCESSING

The audio recordings of license plate data and periodic time observations were transcribed into Microsoft Excel worksheets. Transcriptions were checked for consistency of entry during preprocessing steps prior to the license plate matching procedure programmed to extract the information used in the analysis described in this chapter.

Periodic time observations in the worksheets were converted to a uniform timeline expressed in seconds from the synchronized beginning of each 2.5-hour survey period.

By using [2.5 hours = 150 minutes = 9000 seconds] as a conversion factor, time of day notations were expressed as values between 0 (beginning of survey) and 9000 (end of survey). Sequential license plate records between time notations were then assigned linear time values in proportion to the number of entries between time values. All time values were expressed to the nearest second.

It is noted that this assignment relies upon a working assumption that the distribution of vehicles between time points would be relatively uniform. This assumption also depends upon a reasonable frequency of time observations rather than the absolute accuracy of individual observations.

Before the time values were calculated for the listing of passenger vehicle license plates during the AM and PM surveys, each sequential list was screened for the presence of entries indicating heavy vehicles (T=truck, B=bus) or passenger vehicles with unreadable plates (A=auto, C=car, M=motorcycle). As stated previously, such records were removed from all data input lists prior to the matching procedure. Table A.01 shows the number of transcribed license plates and the number of excluded records for each of the twelve stations during the AM and PM surveys.

Table A.01 also shows that the data transcriptions contained small numbers of entries which could not be successfully translated when the Excel worksheets were converted to .dbf format database tables. These translation failures are attributed to worksheet entries returning invalid cell addresses, e.g. "-N86", where a right aligned three character text entry had been attended. The number of such invalid records, when present, is small.

TABLE A.01 : License Plate Data Preprocessing Summary

Station Filename	Transcribed Records	B	T	A	M	C	X	Net * Plates	Percent Valid Records
AM 1 in	**796**	17	1	0	0	0	2	**776**	97.5%
AM 2 in	**488**	0	80	3	0	0	1	**404**	82.8%
AM 3 in	**1151**	4	63	33	0	0	2	**1049**	91.1%
AM 4 in	**874**	1	98	2	1	0	2	**770**	88.1%
AM 5 in	**943**	1	76	16	0	3	0	**847**	89.8%
AM 6 in	**215**	0	23	0	0	0	0	**192**	89.3%
AM A out	**713**	1	58	0	0	0	4	**650**	91.2%
AM B out	**2332**	0	123	41	0	2	4	**2162**	92.7%
AM C out	**1081**	2	12	7	1	0	4	**1055**	97.6%
AM D out	**565**	0	110	71	2	1	3	**378**	66.9%
AM E out	**456**	0	39	11	0	0	0	**406**	89.0%
AM F out	**334**	0	21	4	0	0	1	**308**	92.2%
PM 1 in	**769**	4	0	0	0	0	4	**761**	99.0%
PM 2 in	**1880**	0	71	85	0	0	3	**1721**	91.5%
PM 3 in	**1788**	1	39	71	0	0	0	**1677**	93.8%
PM 4 in	**846**	0	82	21	0	0	3	**740**	87.5%
PM 5 in	**737**	1	36	25	0	0	0	**675**	91.6%
PM 6 in	**378**	0	36	8	0	0	4	**330**	87.3%
PM A out	**1323**	14	88	25	0	0	3	**1193**	90.2%
PM B out	**1083**	0	106	49	0	0	2	**926**	85.5%
PM C out	**1576**	1	36	51	0	0	4	**1484**	94.2%
PM D out	**913**	0	97	30	0	0	2	**784**	85.9%
PM E out	**641**	0	1	76	0	0	0	**564**	88.0%
PM F out	**469**	0	4	24	0	0	0	**441**	94.0%

B= School bus [license plate not recorded]
T= Truck [license plate not recorded]

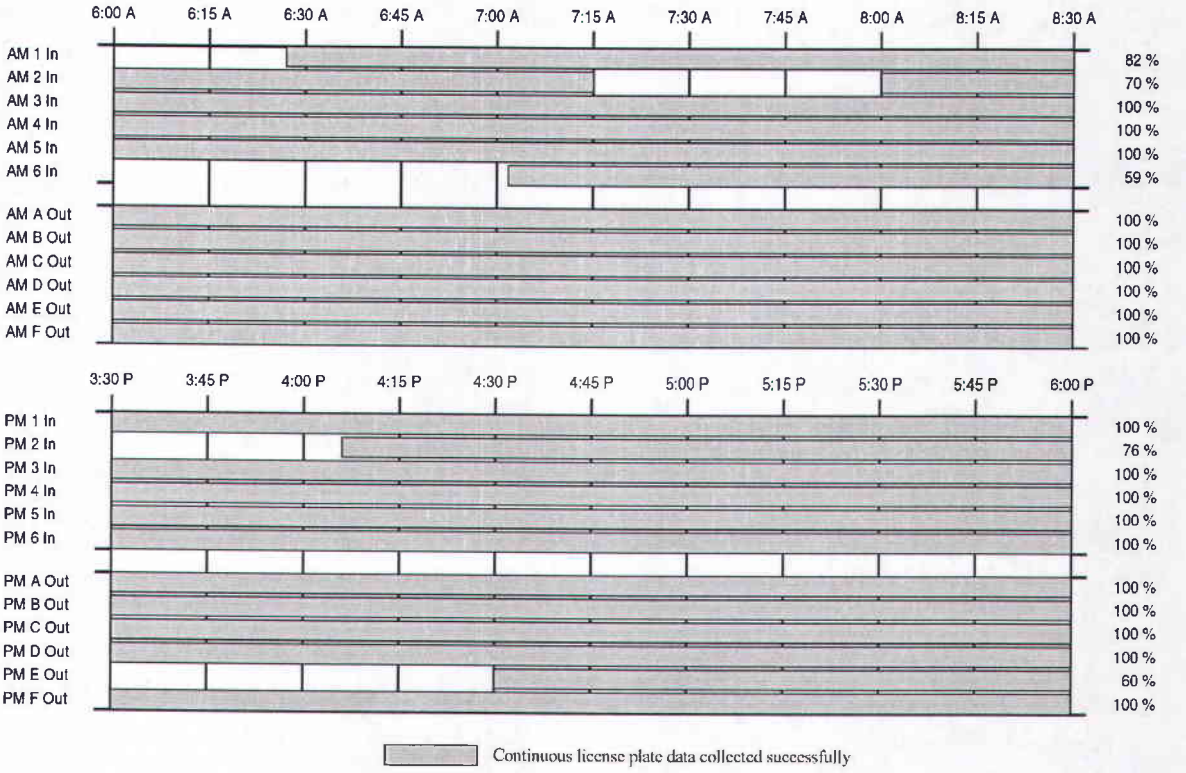
A= Automobile [license plate illegible]
M= Motorcycle [license plate illegible]
C= Car [auto] [license plate illegible]

X= Invalid plate transcription

*** Net plates = Transcribed Records less [B, T, A, M, C, X]**

During the transcription and data preprocessing tasks, several instances of recording lapses were taken into account. These lapses are attributed to personnel error, e.g. failure to properly activate the voice recorder. The presence of periodic time points in the unaffected portions of each recording supported extrapolation of linear time lines to all records. Figure A.02 shows the occurrence and duration of the recording lapses and indicates the amount of usable data as a percentage of total survey time. Evaluation of these lapses suggests that the survey data were not overly compromised.

FIGURE A.02 : Occurrence and Duration of Survey Recording Gaps



LICENSE PLATE MATCHING PROCEDURE

The synchronized license plate survey was designed to detect the number of through vehicular trips using the SR 9 corridor in the Greenfield area. Through trips are made by vehicles entering the corridor at one of the inbound stations [1-6] and exiting the corridor at one of the outbound stations [A-F].

Knowledge of the usual driving time to traverse the SR 9 corridor during the survey period is essential in determining which trips are, in fact, through trips. Simple matching of license plates detected at two different stations in a survey lasting 2.5 hours is insufficient for this determination. A specific license plate at an inbound station must not only be identified at an outbound station; it must also have occurred with an appropriate time interval between observations.

For example, a vehicle entering at Station 2 IN (eastbound I-70 exit ramp at SR 9) and exiting at Station D OUT (southbound SR 9 at the southern limits of Greenfield) must have sufficient time to travel 4.2 miles in the stream of traffic using SR 9. However, the time allowed for this action must not be so great that intermediate stops may have been made.

For the purpose of this survey, allowable ranges of driving time between inbound and outbound stations were estimated by repeated travel across the study area. Minimum and maximum times for each trip interchange are displayed in Table A.02 with times expressed both in minutes and seconds.

The matrix of trip interchanges in this table shows inbound (origin) stations along the left-hand side and outbound (destination) stations along the top. This organization will be used in the remainder of this chapter. Moreover, the matrix is one-directional; that is, origin-destination pairs always begin at an inbound (1-6) station and end at an outbound station (A-F).

TABLE A.02 : Minimum / Maximum Station to Station Drive Times

TIME IN MINUTES		Outbound					
		A	B	C	D	E	F
Inbound	1		2/6	12/20	12/20	12/20	2/6
	2	2/6		10/17	10/17	10/17	
	3	12/20	10/17		9/14	7/13	9/16
	4	12/20	10/17	9/14		7/13	10/17
	5	12/20	10/17	7/13	7/13		9/16
	6	2/6		9/16	10/17	9/16	

TIME IN SECONDS		Outbound					
		A	B	C	D	E	F
Inbound	1		120/360	720/1200	720/1200	720/1200	120/360
	2	120/360		600/1020	600/1020	600/1020	
	3	720/1200	600/1020		540/840	420/780	540/960
	4	720/1200	600/1020	540/840		420/780	600/1020
	5	720/1200	600/1020	420/780	420/780		540/960
	6	120/360		540/960	600/1020	540/960	

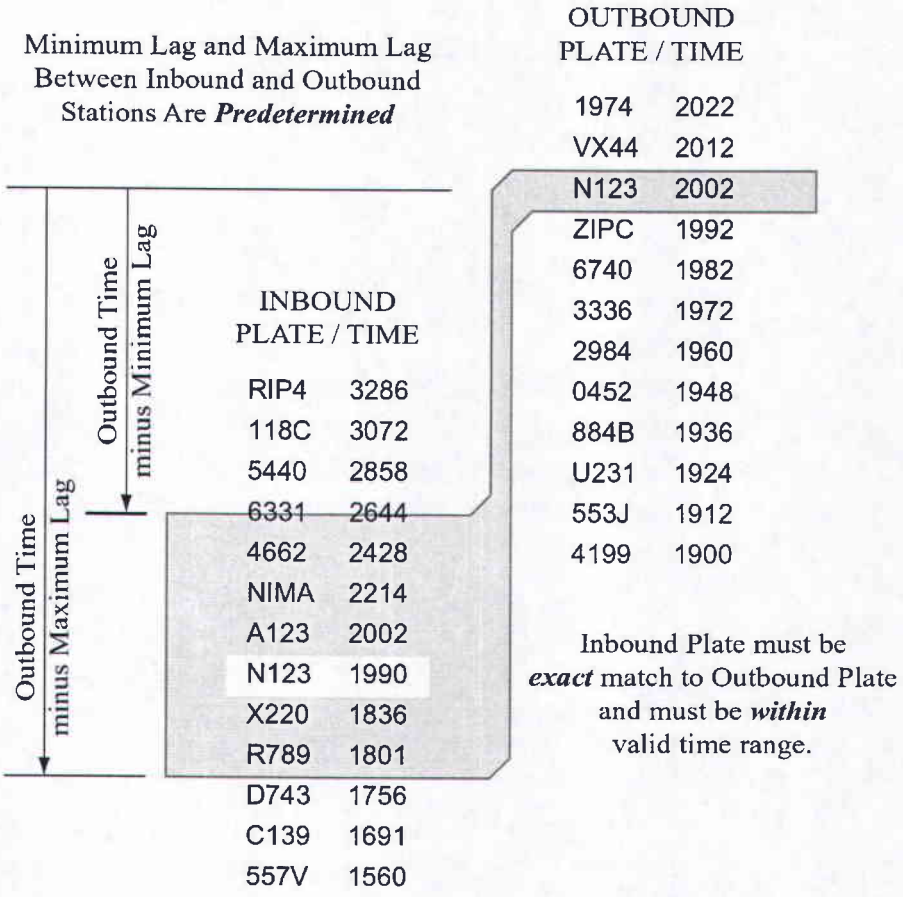
By definition, through trips must begin and end at different locations relative to the SR 9 corridor; therefore, comparisons between inbound and outbound data at the same geographic location were not made; e.g. license plates from station 1 IN are not compared to plates recorded at A OUT. Origin-destination pairs which do not meet this through trip definition are shaded and have no values.

Database files developed by the preprocessing steps consist of one record per recorded license plate containing the four characters and a sequential time value. Files were named for the survey period and station information contained in the file, e.g. AM_1_IN or PM A_OUT.

The plate matching algorithm was implemented in a series of routines in Microsoft FoxPro database management software. A single illustrative description will be used in the paragraphs that follow. All origin-destination pairs were subjected to the same straightforward procedure.

Because the through trip origin-destination pairs are one-directional and time synchronized, the matching algorithm selected for this procedure takes a specified outbound station, for example AM A OUT and reads the minimum and maximum time values established for trips from a single inbound list. Inbound AM_2_IN is the first applicable inbound list for AM_A_OUT. The program sequentially reads each plate record in the AM_A_OUT file and its corresponding time value (elapsed time in seconds from the beginning of the survey) and calculates the minimum and maximum allowable times for a potential inbound observation to have occurred. This algorithm is schematically illustrated by Figure A.03.

FIGURE A.03 : License Plate Matching Validation Parameters



If a plate record in the AM_2_IN file is found, and if that the time value of that record falls within the established range, then a copy of that record is written to a third file containing 2-to-A through trip records. If no time eligible match is found, no record is written. The program then reads the next record in AM_A_OUT and repeats the comparison–write/no-write subroutine, continuing until all records in AM_A_OUT have been compared against all records in AM_2_IN.

The program then performs a similar comparison between all records in AM_A_OUT and records in AM_3_IN and continues until AM_4_IN, AM_5_IN, and AM_6_IN are similarly examined. The entire process is repeated in turn for each outbound station, with each repetition generating a file of origin-destination matches identified by survey period and stations.

The number of records in each of the output files equals the number of time constrained matching license plates between one specified inbound station and one specified outbound station. By the design of the matching routine, the number of records is the number of through trips from that station to station pair. Table A.03 displays the number of raw AM and PM through trip matches in the matrix format introduced above.

TABLE A.03 : Raw AM and PM Through Trip Matches

Raw AM Matches		Outbound					
		A	B	C	D	E	F
Inbound	1		94	10	9	4	11
	2	16		1	0	1	
	3	10	7		2	20	3
	4	25	36	11		7	3
	5	6	26	44	6		2
	6	6		1	0	1	

Raw PM Matches		Outbound					
		A	B	C	D	E	F
Inbound	1		57	11	27	2	8
	2	164		14	20	16	
	3	13	7		12	58	5
	4	73	8	7		2	8
	5	10	10	47	4		1
	6	21		4	2	0	

ADJUSTMENTS TO THE RAW THROUGH TRIP DATA

After tabulation of the AM and PM matching routines, two procedural adjustments were made to the raw through trip data. One adjustment was made to account for (1) missing data associated with gaps in survey recording [See Figure A.02]. The other adjustment reconciled minor discrepancies between the net number of transcribed license plates [See Table A.01] and the number of vehicles detected by INDOT mechanical vehicle counts during the day of the survey.

The time adjustment was made with the assumption that the average frequency of through trips per unit of time during the recording gaps would be equivalent to the average frequency of through trips during the remainder of the recording. This adjustment is accomplished by a simple extrapolation of each cell in the raw match matrix from the actual number of recording seconds achieved during each station to station interchanges. Table A.04 illustrates the results of this extrapolation for the AM and PM surveys, respectively.

The calculations to extrapolate time adjusted matches multiply the raw match cell entry by a factor of 9000 potential survey seconds divided by the actual number of recorded seconds available to the special cell, for example :

Station 1 to Station B = 94; 94 x (9000 / 7380) = 115 rounded to an integer

Station 4 to Station A = 25; 25 x (9000 / 9000) = 25 rounded to an integer

TABLE A.04 : Calculation of Time Adjusted AM and PM Matches

Raw AM Matches

		Outbound					
		A	B	C	D	E	F
Inbound	1		94	10	9	4	11
	2	16		1	0	1	
	3	10	7		2	20	3
	4	25	36	11		7	3
	5	6	26	44	6		2
	6	6		1	0	1	

Raw PM Matches

		Outbound					
		A	B	C	D	E	F
Inbound	1		57	11	27	2	8
	2	164		14	20	16	
	3	13	7		12	58	5
	4	73	8	7		2	8
	5	10	10	47	4		1
	6	21		4	2	0	

AM Seconds

		Outbound					
		A	B	C	D	E	F
Inbound	1		7380	7380	7380	7380	7380
	2	6300		6300	6300	6300	
	3	9000	9000		9000	9000	9000
	4	9000	9000	9000		9000	9000
	5	9000	9000	9000	9000		9000
	6	5280		5280	5280	5280	

PM Seconds

		Outbound					
		A	B	C	D	E	F
Inbound	1		9000	9000	9000	5400	9000
	2	6840		6840	6840	5400	
	3	9000	9000		9000	5400	9000
	4	9300	9300	9300		5400	9300
	5	9000	9000	9000	9000		9000
	6	9000		9000	9000	5400	

Time Adjusted AM Matches

		Outbound					
		A	B	C	D	E	F
Inbound	1		115	12	11	5	13
	2	23		1	0	1	
	3	10	7		2	20	3
	4	25	36	11		7	3
	5	6	26	44	6		2
	6	10		2	0	2	

Time Adjusted PM Matches

		Outbound					
		A	B	C	D	E	F
Inbound	1		57	11	27	3	8
	2	216		18	26	27	
	3	13	7		12	97	5
	4	71	8	7		3	8
	5	10	10	47	4		1
	6	21		4	2	0	

Table A.04 also displays the results of a secondary expansion of the time adjusted matches to account for differences between the net number of usable vehicle plates at each license plate survey station as compared to the total number of vehicles mechanically counted at the same station.

A secondary expansion of the time adjusted matches was then made to proportionally balance the matrix of through trips after expanding row and column control totals to correspond to the total of vehicles reported at each station during the license plate survey. Although mathematically straightforward, the rationale behind this expansion require a brief explanation.

The sum of values in each row of the time adjusted AM or PM matrix represents the total number of matches at each inbound survey station. The sum of values in each column of the same matrix represents the total number of matches at each outbound station. The matrix is balanced because the values in its cell contribute to both row and column totals.

There is an implicit relationship between the number of through trips passing each survey station and the total volume of vehicles passing the same station. Recall that in Table A.01 the total number of transcribed records was reduced by the number of heavy vehicles, passenger vehicles with unreadable plates, and miscellaneous invalid transcriptions. The matrix of time adjusted matches was systematically developed from the net number of usable plates, not from the total number of plates.

Time adjusted matrix row totals were expanded in proportion to the ratio between the total number of inbound survey vehicles divided by the net number of inbound plates at a station. Matrix column totals were similarly expanded by the ratio between total outbound survey vehicles and net outbound plates at each station.
Differences between the time adjusted matrix row and column control totals and the expanded totals were then distributed to matrix cells proportionally to the ratio between a cell's time adjusted value and its percentage of the row or column total. Calculations of this volume expansion were constrained to integer values (unit vehicles), so a portion of the calculations involving very small differences or very small cell values did not produce a complete unit value.

The results of this volume based expansion are shown in Table A.05. Matrix values in this table are the basis for all subsequent adjustments of the license plate survey data to incorporate INDOT mechanical vehicle counts and vehicle classification counts.

TABLE A.05 : Volume Expanded AM and PM Through Trips

Volume Expanded AM Through		Outbound					
		A	B	C	D	E	F
Inbound	1		121	12	14	6	14
	2	27		1	0	1	
	3	11	8		3	22	3
	4	28	40	12		8	3
	5	7	29	47	8		2
	6	11		2	0	2	

Volume Expanded PM Through		Outbound					
		A	B	C	D	E	F
Inbound	1		63	12	30	3	8
	2	238		20	29	31	
	3	14	8		14	107	5
	4	80	9	8		3	9
	5	11	12	51	5		1
	6	24		5	2	0	

Calculations of the expanded control totals defined above are summarized in Table A.06 on the following page. Note that this table is based on the data presented in Table A.01.
For the purpose of expanding the control totals, heavy vehicles (truck or bus) were considered to be vehicles undifferentiated from passenger vehicles within the traffic streams monitored during the license plate survey.

Later portions of this chapter will document the need and methods used to differentiate heavy vehicles from passenger vehicles. An initial assumption that the distribution of heavy vehicles at individual survey stations would be similar to the distribution of passenger vehicles was detected during analysis of vehicle classification data. Awareness of the different impacts from the two types of vehicles on local traffic flow will contribute to the understanding of the remainder of this chapter.

Awareness of the perception of heavy vehicles on traffic flow will be equally important to other portions of this report.

TABLE A.06 : Calculation of Station Volume Based Expansion of Through Trips

Filename	Transcribed Records	Net * Plates	Time Adjusted Matched Plates	Volume Adjusted Through Trips	Difference	Logged Seconds	Time Adjusted Total Trips
AM 1 in	**796**	**776**	156	160	4	7380	971
AM 2 in	**488**	**404**	25	30	5	6300	697
AM 3 in	**1151**	**1049**	42	46	4	9000	1151
AM 4 in	**874**	**770**	82	93	11	9000	874
AM 5 in	**943**	**847**	84	94	10	9000	943
AM 6 in	**215**	**192**	14	16	2	5280	366
AM A out	**713**	**650**	74	81	7	9000	713
AM B out	**2332**	**2162**	184	198	14	9000	2332
AM C out	**1081**	**1055**	70	72	2	9000	1081
AM D out	**565**	**378**	19	28	9	9000	565
AM E out	**456**	**406**	35	39	4	9000	456
AM F out	**334**	**308**	21	23	2	9000	334
PM 1 in	**769**	**761**	106	107	1	9000	769
PM 2 in	**1880**	**1721**	287	314	27	6840	2474
PM 3 in	**1788**	**1677**	134	143	9	9000	1788
PM 4 in	**846**	**740**	97	111	14	9300	819
PM 5 in	**737**	**675**	72	79	7	9000	737
PM 6 in	**378**	**330**	27	31	4	9000	378
PM A out	**1323**	**1193**	331	367	36	9000	1323
PM B out	**1083**	**926**	82	96	14	9000	1083
PM C out	**1576**	**1484**	87	92	5	9000	1576
PM D out	**913**	**784**	71	83	12	9000	913
PM E out	**641**	**564**	130	148	18	5400	1068
PM F out	**469**	**441**	22	23	1	9000	469

Table A.06 also shows the time adjusted total trips at each survey station. This adjustment was a simple extrapolation of the total number of transcribed records at each station, as was done independently for matching through trips. Again, the time adjustment was based on the assumption that the average frequency of vehicles passing a station during gaps in the recordings would be equivalent to the average frequency during the remainder of the recording.

The extrapolation multiplies the number of transcribed records by a factor of 9000 potential survey seconds divided by the actual number of logged recording seconds, for example :

Station AM 1 IN = 796 ; 796 x (9000 / 7380) = 971 rounded to an integer

Station PM 1 IN = 769 ; 769 x (9000 / 9000) = 769 rounded to an integer

Summary of AM and PM License Plate Survey Results

Tables A.07 (a) and (b) show the adjusted results of the 2.5 hour license plate surveys during morning and afternoon periods of peak traffic volumes along the SR 9 corridor in the Greenfield vicinity. Each table is organized to show through trips as components of the traffic streams entering the corridor at inbound survey stations and also as components of the traffic streams leaving the corridor at outbound survey stations.

Table A.07 (a) : Through Vehicle Trip Analysis – 6:00 AM to 8:30 PM, August 22, 2001

Enter at 1 :	971		Volume	Percent
		Exit at B :	121	12.5%
		Exit at C :	12	1.2%
		Exit at D :	14	1.4%
		Exit at E :	6	0.6%
		Exit at F :	14	1.4%
		Total Through:	**167**	**17.2%**
		To Other :	804	82.8%
		Total :	971	100.0%

Exit at A :	713		Volume	Percent
		Enter at 2 :	27	3.8%
		Enter at 3 :	11	1.5%
		Enter at 4 :	28	3.9%
		Enter at 5 :	7	1.0%
		Enter at 6 :	11	1.5%
		Total Through:	**84**	**11.8%**
		From Other :	629	88.2%
		Total :	713	100.0%

Enter at 2 :	697		Volume	Percent
		Exit at A :	27	3.9%
		Exit at C :	1	0.1%
		Exit at D :	0	0.0%
		Exit at E :	1	0.1%
		Total Through:	**29**	**4.2%**
		To Other :	668	95.8%
		Total :	697	100.0%

Exit at B :	2332		Volume	Percent
		Enter at 1 :	121	5.2%
		Enter at 3 :	8	0.3%
		Enter at 4 :	40	1.7%
		Enter at 5 :	29	1.2%
		Total Through:	**198**	**8.5%**
		From Other :	2134	91.5%
		Total :	2332	100.0%

Enter at 3 :	1151		Volume	Percent
		Exit at A :	11	1.0%
		Exit at B :	8	0.7%
		Exit at D :	3	0.3%
		Exit at E :	22	1.9%
		Exit at F :	3	0.3%
		Total Through:	**47**	**4.1%**
		To Other :	1104	95.9%
		Total :	1151	100.0%

Exit at C :	1081		Volume	Percent
		Enter at 1 :	12	1.1%
		Enter at 2 :	1	0.1%
		Enter at 4 :	12	1.1%
		Enter at 5 :	47	4.3%
		Enter at 6 :	2	0.2%
		Total Through:	**74**	**6.8%**
		From Other :	1007	93.2%
		Total :	1081	100.0%

Enter at 4 :	874		Volume	Percent
		Exit at A :	28	3.2%
		Exit at B :	40	4.6%
		Exit at C :	12	1.4%
		Exit at E :	8	0.9%
		Exit at F :	3	0.3%
		Total Through:	**91**	**10.4%**
		To Other :	783	89.6%
		Total :	874	100.0%

Exit at D :	565		Volume	Percent
		Enter at 1 :	14	2.5%
		Enter at 2 :	0	0.0%
		Enter at 3 :	3	0.5%
		Enter at 5 :	8	1.4%
		Enter at 6 :	0	0.0%
		Total Through:	**25**	**4.4%**
		From Other :	540	95.6%
		Total :	565	100.0%

Enter at 5 :	943		Volume	Percent
		Exit at A :	7	0.7%
		Exit at B :	29	3.1%
		Exit at C :	47	5.0%
		Exit at D :	8	0.8%
		Exit at F :	2	0.2%
		Total Through:	**93**	**9.9%**
		To Other :	850	90.1%
		Total :	943	100.0%

Exit at E :	456		Volume	Percent
		Enter at 1 :	6	1.3%
		Enter at 2 :	1	0.2%
		Enter at 3 :	22	4.8%
		Enter at 4 :	8	1.8%
		Enter at 6 :	2	0.4%
		Total Through:	**39**	**8.6%**
		From Other :	417	91.4%
		Total :	456	100.0%

Enter at 6 :	366		Volume	Percent
		Exit at A :	11	3.0%
		Exit at C :	2	0.5%
		Exit at D :	0	0.0%
		Exit at E :	2	0.5%
		Total Through:	**15**	**4.1%**
		To Other :	351	95.9%
		Total :	366	100.0%

Exit at F :	334		Volume	Percent
		Enter at 1 :	14	4.2%
		Enter at 3 :	3	0.9%
		Enter at 4 :	3	0.9%
		Enter at 5 :	2	0.6%
		Total Through:	**22**	**6.6%**
		From Other :	312	93.4%
		Total :	334	100.0%

Table A.07 (b) : Through Vehicle Trip Analysis – 3:30 PM to 6:00 PM, August 22, 2001

Enter at 1 :	769		Volume	Percent
		Exit at B :	63	8.2%
		Exit at C :	12	1.6%
		Exit at D :	30	3.9%
		Exit at E :	3	0.4%
		Exit at F :	8	1.0%
		Total Through:	**116**	**15.1%**
		To Other :	653	84.9%
		Total :	769	100.0%

Exit at A :	1323		Volume	Percent
		Enter at 2 :	238	18.0%
		Enter at 3 :	14	1.1%
		Enter at 4 :	80	6.0%
		Enter at 5 :	11	0.8%
		Enter at 6 :	24	1.8%
		Total Through:	**367**	**27.7%**
		From Other :	956	72.3%
		Total :	1323	100.0%

Enter at 2 :	2474		Volume	Percent
		Exit at A :	238	9.6%
		Exit at C :	20	0.8%
		Exit at D :	29	1.2%
		Exit at E :	31	1.3%
		Total Through:	**318**	**12.9%**
		To Other :	2156	87.1%
		Total :	2474	100.0%

Exit at B :	1083		Volume	Percent
		Enter at 1 :	63	5.8%
		Enter at 3 :	8	0.7%
		Enter at 4 :	9	0.8%
		Enter at 5 :	12	1.1%
		Total Through:	**92**	**8.5%**
		From Other :	991	91.5%
		Total :	1083	100.0%

Enter at 3 :	1788		Volume	Percent
		Exit at A :	14	0.8%
		Exit at B :	8	0.4%
		Exit at D :	14	0.8%
		Exit at E :	107	6.0%
		Exit at F :	5	0.3%
		Total Through:	**148**	**8.3%**
		To Other :	1640	91.7%
		Total :	1788	100.0%

Exit at C :	1576		Volume	Percent
		Enter at 1 :	12	0.8%
		Enter at 2 :	20	1.3%
		Enter at 4 :	8	0.5%
		Enter at 5 :	51	3.2%
		Enter at 6 :	5	0.3%
		Total Through:	**96**	**6.1%**
		From Other :	1480	93.9%
		Total :	1576	100.0%

Enter at 4 :	819		Volume	Percent
		Exit at A :	80	9.8%
		Exit at B :	9	1.1%
		Exit at C :	8	1.0%
		Exit at E :	3	0.4%
		Exit at F :	9	1.1%
		Total Through:	**109**	**13.3%**
		To Other :	710	86.7%
		Total :	819	100.0%

Exit at D :	913		Volume	Percent
		Enter at 1 :	30	3.3%
		Enter at 2 :	29	3.2%
		Enter at 3 :	14	1.5%
		Enter at 5 :	5	0.5%
		Enter at 6 :	2	0.2%
		Total Through:	**80**	**8.8%**
		From Other :	833	91.2%
		Total :	913	100.0%

Enter at 5 :	737		Volume	Percent
		Exit at A :	11	1.5%
		Exit at B :	12	1.6%
		Exit at C :	51	6.9%
		Exit at D :	5	0.7%
		Exit at F :	1	0.1%
		Total Through:	**80**	**10.9%**
		To Other :	657	89.1%
		Total :	737	100.0%

Exit at E :	1068		Volume	Percent
		Enter at 1 :	3	0.3%
		Enter at 2 :	31	2.9%
		Enter at 3 :	107	10.0%
		Enter at 4 :	3	0.3%
		Enter at 6 :	0	0.0%
		Total Through:	**144**	**13.5%**
		From Other :	924	86.5%
		Total :	1068	100.0%

Enter at 6 :	378		Volume	Percent
		Exit at A :	24	6.3%
		Exit at C :	5	1.3%
		Exit at D :	2	0.5%
		Exit at E :	0	0.0%
		Total Through:	**31**	**8.2%**
		To Other :	347	91.8%
		Total :	378	100.0%

Exit at F :	469		Volume	Percent
		Enter at 1 :	8	1.7%
		Enter at 3 :	5	1.1%
		Enter at 4 :	9	1.9%
		Enter at 5 :	1	0.2%
		Total Through:	**23**	**4.9%**
		From Other :	446	95.1%
		Total :	469	100.0%

In Tables A.07 (a) and (b) data representing the total volume of traffic at each station consist of the adjusted total number of transcribed vehicle records. Following sections of this chapter compare these volumes to INDOT mechanical vehicle counts and vehicle classification counts.

Discussion of Mid-Day Heavy Vehicle License Plate Survey

As stated in the Data Collection section at the beginning of this chapter, a mid-day survey of heavy vehicles using the SR 9 corridor was conducted between the hours of 11:00 AM and 1:30 PM. During this 2.5 hour survey, observers recorded the identifiable and readable license plates of heavy (truck and bus) vehicles only. Passenger vehicles were neither recorded or counted.

Uncertainty about the difficulty and time required to read and record license plates on heavy vehicles and concerns about personnel fatigue contributed to the decision to not change the instructions for recording time of day observations during the survey.

A consequence of this decision, combined with the relatively low volume of heavy vehicles as compared to passenger vehicles, was the inability to interpolate time values between the limited number of time of day observations.

Absence of time values and the coincidental absence of recording gaps eliminated the need for a portion of the data preprocessing steps used with AM and PM surveys. As with the passenger vehicle surveys data transcriptions were checked for transcription consistency before conversion to .dbf format database tables.

Absence of time values in the mid-day data required a modification of the matching procedures used to detect and count through trips. By this qualification, a through trip was defined as the simple exact match between an outbound license plate and any occurrence of the same plate in the specified inbound list. This qualification was supported by visual inspection of the heavy vehicle transcriptions. Visual inspection did not reveal instances of obvious or systematic repetition of 4-character combinations which would have compromised the data.

TABLE A.08 : Mid-Day Heavy Vehicle Matches

MD Through Trucks		Outbound					
		A	B	C	D	E	F
Inbound	1		6	1	16	0	1
	2	8		4	3	6	
	3	2	1		2	1	0
	4	21	4	1		3	2
	5	4	5	9	5		0
	6	7		0	11	0	

Table A.08 shows the matrix of mid-day through trip matches. The perception that this matrix contains very low volumes should be balanced by the observation that the data represent only heavy, multi-axle vehicles – a definition excluding light and medium size trucks.

Table A.09 on the following page shows the results of the 2.5 hour mid-day heavy vehicle license plate survey in the format used previously for the AM and PM surveys. This table is organized to show through trips as components of the heavy vehicle streams entering the SR 9 corridor at inbound survey stations and also as components of the heavy vehicle streams leaving the corridor at outbound survey stations.

Enter at 1 :	82		Volume	Percent
		Exit at B :	6	7.3%
		Exit at C :	1	1.2%
		Exit at D :	16	19.5%
		Exit at E :	0	0.0%
		Exit at F :	1	1.2%
		Total Through:	24	29.3%
		To Other :	58	70.7%
		Total :	82	100.0%

Exit at A :	127		Volume	Percent
		Enter at 2 :	8	6.3%
		Enter at 3 :	2	1.6%
		Enter at 4 :	21	16.5%
		Enter at 5 :	4	3.1%
		Enter at 6 :	7	5.5%
		Total Through:	42	33.1%
		From Other :	85	66.9%
		Total :	127	100.0%

Enter at 2 :	120		Volume	Percent
		Exit at A :	8	6.7%
		Exit at C :	4	3.3%
		Exit at D :	3	2.5%
		Exit at E :	6	5.0%
		Total Through:	21	17.5%
		To Other :	99	82.5%
		Total :	120	100.0%

Exit at B :	106		Volume	Percent
		Enter at 1 :	6	5.7%
		Enter at 3 :	1	0.9%
		Enter at 4 :	4	3.8%
		Enter at 5 :	5	4.7%
		Total Through:	16	15.1%
		From Other :	90	84.9%
		Total :	106	100.0%

Enter at 3 :	57		Volume	Percent
		Exit at A :	2	3.5%
		Exit at B :	1	1.8%
		Exit at D :	2	3.5%
		Exit at E :	1	1.8%
		Exit at F :	0	0.0%
		Total Through:	6	10.5%
		To Other :	51	89.5%
		Total :	57	100.0%

Exit at C :	56		Volume	Percent
		Enter at 1 :	1	1.8%
		Enter at 2 :	4	7.1%
		Enter at 4 :	1	1.8%
		Enter at 5 :	9	16.1%
		Enter at 6 :	0	0.0%
		Total Through:	15	26.8%
		From Other :	41	73.2%
		Total :	56	100.0%

Enter at 4 :	73		Volume	Percent
		Exit at A :	21	28.8%
		Exit at B :	4	5.5%
		Exit at C :	1	1.4%
		Exit at E :	3	4.1%
		Exit at F :	2	2.7%
		Total Through:	31	42.5%
		To Other :	42	57.5%
		Total :	73	100.0%

Exit at D :	124		Volume	Percent
		Enter at 1 :	16	12.9%
		Enter at 2 :	3	2.4%
		Enter at 3 :	2	1.6%
		Enter at 5 :	5	4.0%
		Enter at 6 :	11	8.9%
		Total Through:	37	29.8%
		From Other :	87	70.2%
		Total :	124	100.0%

Enter at 5 :	56		Volume	Percent
		Exit at A :	4	7.1%
		Exit at B :	5	8.9%
		Exit at C :	9	16.1%
		Exit at D :	5	8.9%
		Exit at F :	0	0.0%
		Total Through:	23	41.1%
		To Other :	33	58.9%
		Total :	56	100.0%

Exit at E :	22		Volume	Percent
		Enter at 1 :	0	0.0%
		Enter at 2 :	6	27.3%
		Enter at 3 :	1	4.5%
		Enter at 4 :	3	13.6%
		Enter at 6 :	0	0.0%
		Total Through:	10	45.5%
		From Other :	12	54.5%
		Total :	22	100.0%

Enter at 6 :	43		Volume	Percent
		Exit at A :	7	16.3%
		Exit at C :	0	0.0%
		Exit at D :	11	25.6%
		Exit at E :	0	0.0%
		Total Through:	18	41.9%
		To Other :	25	58.1%
		Total :	43	100.0%

Exit at F :	19		Volume	Percent
		Enter at 1 :	1	5.3%
		Enter at 3 :	0	0.0%
		Enter at 4 :	2	10.5%
		Enter at 5 :	0	0.0%
		Total Through:	3	15.8%
		From Other :	16	84.2%
		Total :	19	100.0%

TABLE A.09 : Through Heavy Vehicle Trip Analysis – 11:00 AM to 1:30 PM, August 22, 2001

Preliminary comparison of Table A.09 with Tables A.07 (a) and (b) reveal that the relative distribution of through trips made by heavy vehicles differs from the distribution of through trips by passenger vehicles. Notwithstanding the substantially lower numbers of heavy vehicles, percentage values are not only higher for heavy vehicles but indicate clustering, as compared to generally disperse passenger vehicles. Such clustering suggests that there may be a perception of heavy vehicle concentration along some portions of the SR 9 corridor that outweighs the actual volume of heavy vehicles.

Evaluation of Weekday Through Trip Characteristics

The tabulation of through trips detected by the license plate survey and presented in Tables A.07 (a), A.07 (b), and A.09 reveals some evidence of directional movements associated with morning and afternoon peak traffic periods. The location and size of Greenfield relative to the Indianapolis metropolitan area contribute to logical morning and afternoon commuting patterns on I-70 and US 40.

Movements along SR 9 and through the study corridor are generally less pronounced. The alignment and extent of commercial areas along SR 9 contribute to the blurring between through trips and trips originating or ending in or near the SR 9 corridor. For example, a commuter may leave Indianapolis, enter the vicinity of Greenfield, and use SR 9 for making one or more brief stops before leaving the SR 9 corridor for home. Because of the interaction with intermediate Greenfield destinations, such a commute would not meet the definition of a through trip.

While a through trip might use the same route as the commuter, the through trip makes no intermediate stops. One of the principal objectives of the SR 9 Corridor Study is to quantify the degree of interaction between these two types of trips. Another objective will be to assess the interaction of both types of trips with strictly local travel both originating and ending in Greenfield.

At the request of INDOT, PKG and PIC expanded the findings from the 5-hour license plate survey to a 24-hour basis using the mechanical vehicle counts and vehicle classification counts conducted by INDOT concurrently with the survey. Two possible work plans were tested in the completion of this task.

One assumption was that both passenger vehicle and heavy vehicle through traffic would exhibit generally uniform patterns. If this assumption proved true, estimated through passenger vehicle trips could be deducted from total traffic volumes to show heavy vehicle through trips; however preliminary testing indicated that the data did not meet the requirements of this assumption.

The second assumption was that passenger vehicle and heavy vehicle through traffic could exhibit different overall patterns. This assumption, which proved true, required independent assessment of passenger vehicle and heavy vehicle through volumes prior to comparison with total traffic volumes.

The remainder of this chapter will describe the separate passenger vehicle and heavy vehicle analyses and the development of an overall weekday through trip estimate for the SR 9 corridor.

INDOT MECHANICAL VEHICLE COUNTS AND VEHICLE CLASSIFICATION COUNTS

INDOT mechanical vehicle counts were conducted at numerous locations in and near the SR 9 corridor in the Greenfield vicinity. Table A.10 shows the identification codes and locations for the twelve count locations corresponding to the license plate survey observation stations.

At eight of these twelve INDOT locations standard vehicle counts were recorded continuously through the entire day of the license plate survey. At four INDOT locations mechanical vehicle classification counts were conducted. Vehicle classification counters use an internal analysis of the number and timing of axles passing over the detector tubes to tabulate the number of vehicles fitting fifteen different axle profile types. Post-processing of the data enables tabulation of the various types of vehicles recorded. Such classification was vital to the analysis of the SR 9 corridor survey because it provided a reliable sampling of the number and distribution of heavy vehicles within the overall traffic streams.

TABLE A.10 : Corresponding License Plate Survey and INDOT Vehicle Count Locations

License Plate Survey Station ID	**INDOT Count ID**	**Direction and Location**	**Report Type**
AM/PM **1** IN	60 SB	Southbound SR 9 north of CR 500 N	*Classification*
AM/PM **2** IN	41 EB Off	I-70 Eastbound Off Ramp west of SR 9	Count
AM/PM **3** IN	70 EB	Eastbound US 40 east of CR 75 W	Count
AM/PM **4** IN	10 NB	Northbound SR 9 north of White Oak Dr	*Classification*
AM/PM **5** IN	80 WB	Westbound US 40 east of CR 300 E	Count
AM/PM **6** IN	43 WB Off	I-70 Westbound Off Ramp east of SR 9	Count
AM/PM **A** OUT	60 NB	Northbound SR 9 north of CR 500 N	*Classification*
AM/PM **B** OUT	44 WB On	I-70 Westbound On Ramp west of SR 9	Count
AM/PM **C** OUT	70 WB	Westbound US 40 east of CR 75 W	Count
AM/PM **D** OUT	10 SB	Southbound SR 9 north of White Oak Dr	*Classification*
AM/PM **E** OUT	80 EB	Eastbound US 40 east of CR 300 E	Count
AM/PM **F** OUT	42 EB On	I-70 Eastbound On Ramp east of SR 9	Count

Copies of the INDOT traffic counts are included at the end of this chapter.

Data from the four INDOT vehicle classification count locations at the northern (1 IN, A OUT) and southern (4 IN, D OUT) ends of the SR 9 corridor provide important information about the daily overall traffic patterns and heavy vehicle presence along SR 9. These data are presented in the following Tables A.11, A.12 and Figures A.04, A.05 (1 IN, A OUT) and Tables A.13, A.14 and Figures A.06, A.07 (4 IN, D OUT).

Tables include summaries for the 2.5-hour AM, PM, and Mid-Day periods when the license plate surveys were being conducted. Graphical figures are based on the data tables.

The two inbound locations show maximum peak hour traffic volumes at and near 8 AM, while the two outbound locations show maximum peak hour traffic volumes at and near 5 PM. This pattern is consistent with morning commuter traffic using SR 9 for access to I-70 and US 40 and then returning to the Greenfield vicinity in the afternoon.

In contrast to the overall traffic patterns, heavy vehicles gradually increase to a maximum peak volume in the mid-morning and remain nearly constant through the mid-afternoon before tapering off through the evening and overnight hours.

These observations suggest that there is a brief period in the morning when heavy vehicle concentrations coincide with the peak in passenger vehicle commuters. There is a brief mid-afternoon period of similar, but lower, heavy vehicle and passenger vehicle concentration. Between these two brief peaks, extending between mid-morning and early afternoon, the near constant volume of heavy vehicles becomes a higher percentage of overall traffic because there are relatively fewer automobiles.

TABLE A.11 : Hourly Vehicle Class Volumes at Station 1 IN

AM/PM 1 in [60 SB]

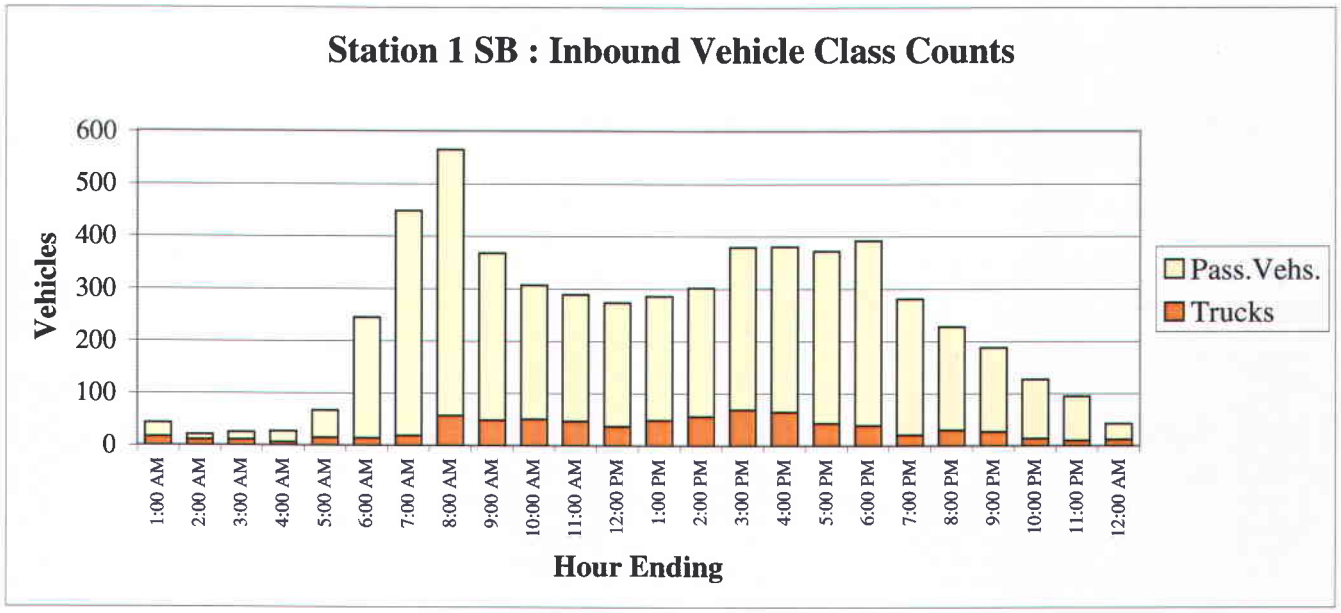
Hour Ending	Vehicle Classes 1 - 3 Pass.Veh.	4 - 15 Trucks	Total	Percent Pass.Veh.	Percent Trucks
1:00 AM	27	16	43	62.8%	37.2%
2:00 AM	10	11	21	47.6%	52.4%
3:00 AM	14	11	25	56.0%	44.0%
4:00 AM	21	6	27	77.8%	22.2%
5:00 AM	52	15	67	77.6%	22.4%
6:00 AM	231	14	245	94.3%	5.7%
7:00 AM	429	19	448	95.8%	4.2%
8:00 AM	508	57	565	89.9%	10.1%
9:00 AM	320	48	368	87.0%	13.0%
10:00 AM	257	50	307	83.7%	16.3%
11:00 AM	243	46	289	84.1%	15.9%
12:00 PM	237	37	274	86.5%	13.5%
1:00 PM	238	48	286	83.2%	16.8%
2:00 PM	246	56	302	81.5%	18.5%
3:00 PM	311	69	380	81.8%	18.2%
4:00 PM	317	64	381	83.2%	16.8%
5:00 PM	329	43	372	88.4%	11.6%
6:00 PM	353	39	392	90.1%	9.9%
7:00 PM	260	21	281	92.5%	7.5%
8:00 PM	198	30	228	86.8%	13.2%
9:00 PM	161	27	188	85.6%	14.4%
10:00 PM	113	14	127	89.0%	11.0%
11:00 PM	84	10	94	89.4%	10.6%
12:00 AM	30	12	42	71.4%	28.6%
24-Hour	4989	763	5752	86.7%	13.3%
6:00a- 8:30a	1097	100	1197	91.6%	8.4%
11:00a- 1:30p	598	113	711	84.1%	15.9%
3:30p - 6:00p	841	114	955	88.1%	11.9%

TABLE A.12 : Hourly Vehicle Class Volumes at Station A OUT

AM/PM A out [60 NB]

Hour Ending	Vehicle Classes 1 - 3 Pass.Veh.	4 - 15 Trucks	Total	Percent Pass.Veh.	Percent Trucks
1:00 AM	40	13	53	75.5%	24.5%
2:00 AM	20	10	30	66.7%	33.3%
3:00 AM	13	6	19	68.4%	31.6%
4:00 AM	19	9	28	67.9%	32.1%
5:00 AM	19	16	35	54.3%	45.7%
6:00 AM	71	20	91	78.0%	22.0%
7:00 AM	195	36	231	84.4%	15.6%
8:00 AM	339	31	370	91.6%	8.4%
9:00 AM	239	60	299	79.9%	20.1%
10:00 AM	192	56	248	77.4%	22.6%
11:00 AM	199	60	259	76.8%	23.2%
12:00 PM	219	61	280	78.2%	21.8%
1:00 PM	279	55	334	83.5%	16.5%
2:00 PM	265	42	307	86.3%	13.7%
3:00 PM	342	56	398	85.9%	14.1%
4:00 PM	467	63	530	88.1%	11.9%
5:00 PM	529	42	571	92.6%	7.4%
6:00 PM	449	26	475	94.5%	5.5%
7:00 PM	382	18	400	95.5%	4.5%
8:00 PM	248	14	262	94.7%	5.3%
9:00 PM	222	20	242	91.7%	8.3%
10:00 PM	134	12	146	91.8%	8.2%
11:00 PM	62	14	76	81.6%	18.4%
12:00 AM	98	6	104	94.2%	5.8%
24-Hour	5042	746	5788	87.1%	12.9%
6:00a- 8:30a	654	97	751	87.1%	12.9%
11:00a- 1:30p	631	137	768	82.2%	17.8%
3:30p - 6:00p	1212	99	1311	92.4%	7.6%

FIGURE A.04 : Inbound Vehicle Class Counts and Percentages at Station 1 IN



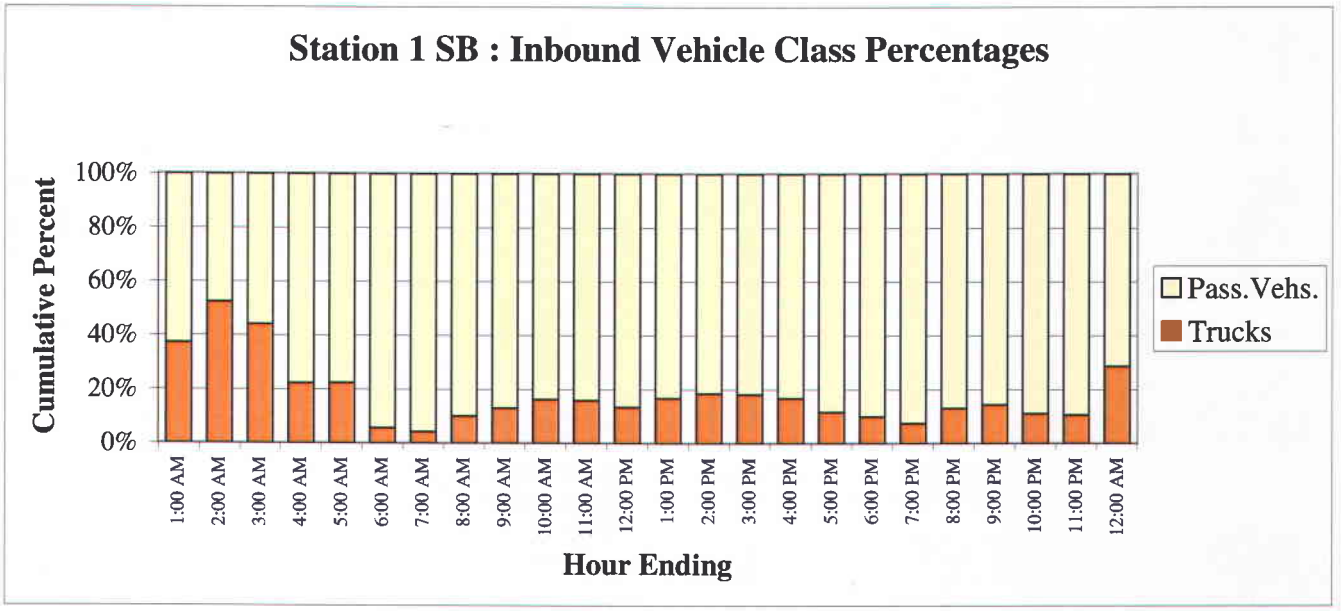
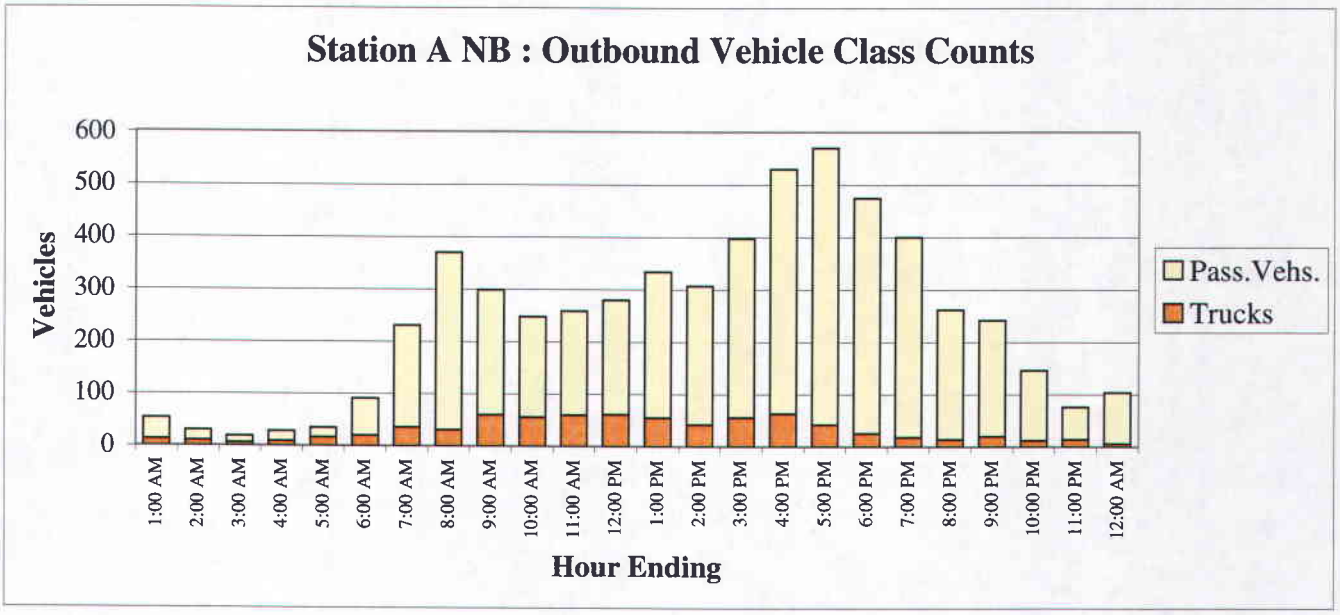


FIGURE A.05 : Outbound Vehicle Class Counts and Percentages at Station A OUT



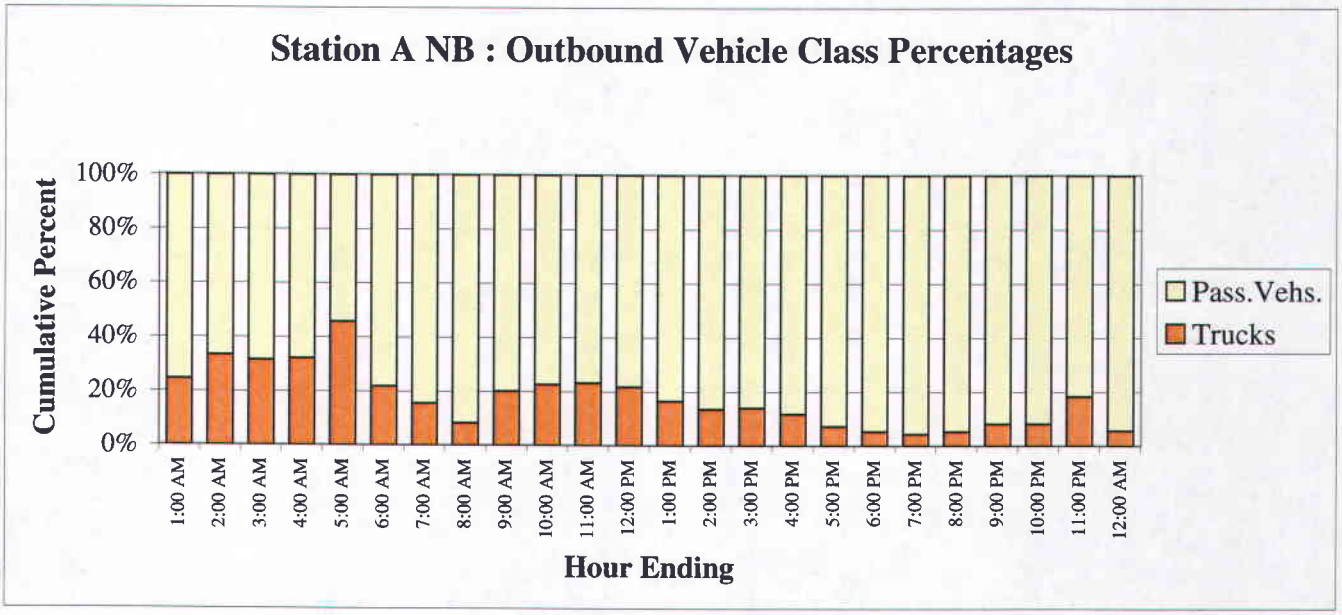


TABLE A.13 : Hourly Vehicle Class Volumes at Station 4 IN

AM/PM 4 in [10 NB]

Hour Ending	Vehicle Classes 1 - 3 Pass.Veh.	4 - 15 Trucks	Total	Percent Pass.Veh.	Percent Trucks
1:00 AM	27	14	41	65.9%	34.1%
2:00 AM	12	10	22	54.5%	45.5%
3:00 AM	14	8	22	63.6%	36.4%
4:00 AM	13	11	24	54.2%	45.8%
5:00 AM	41	15	56	73.2%	26.8%
6:00 AM	146	24	170	85.9%	14.1%
7:00 AM	295	27	322	91.6%	8.4%
8:00 AM	388	47	435	89.2%	10.8%
9:00 AM	252	40	292	86.3%	13.7%
10:00 AM	230	44	274	83.9%	16.1%
11:00 AM	209	43	252	82.9%	17.1%
12:00 PM	206	46	252	81.7%	18.3%
1:00 PM	237	37	274	86.5%	13.5%
2:00 PM	245	35	280	87.5%	12.5%
3:00 PM	250	56	306	81.7%	18.3%
4:00 PM	275	33	308	89.3%	10.7%
5:00 PM	289	34	323	89.5%	10.5%
6:00 PM	323	27	350	92.3%	7.7%
7:00 PM	246	17	263	93.5%	6.5%
8:00 PM	183	12	195	93.8%	6.2%
9:00 PM	119	22	141	84.4%	15.6%
10:00 PM	94	14	108	87.0%	13.0%
11:00 PM	65	10	75	86.7%	13.3%
12:00 AM	43	6	49	87.8%	12.2%
24-Hour	4202	632	4834	86.9%	13.1%
6:00a- 8:30a	809	94	903	89.6%	10.4%
11:00a- 1:30p	566	100	666	85.0%	15.0%
3:30p - 6:00p	750	77	827	90.7%	9.3%

TABLE A.14 : Hourly Vehicle Class Volumes at Station D OUT

AM/PM D out [10 SB]

Hour Ending	Vehicle Classes 1 - 3 Pass.Veh.	4 - 15 Trucks	Total	Percent Pass.Veh.	Percent Trucks
1:00 AM	23	18	41	56.1%	43.9%
2:00 AM	16	11	27	59.3%	40.7%
3:00 AM	11	11	22	50.0%	50.0%
4:00 AM	16	13	29	55.2%	44.8%
5:00 AM	33	13	46	71.7%	28.3%
6:00 AM	101	22	123	82.1%	17.9%
7:00 AM	199	31	230	86.5%	13.5%
8:00 AM	201	49	250	80.4%	19.6%
9:00 AM	199	50	249	79.9%	20.1%
10:00 AM	208	70	278	74.8%	25.2%
11:00 AM	207	59	266	77.8%	22.2%
12:00 PM	213	48	261	81.6%	18.4%
1:00 PM	219	47	266	82.3%	17.7%
2:00 PM	240	54	294	81.6%	18.4%
3:00 PM	260	46	306	85.0%	15.0%
4:00 PM	347	42	389	89.2%	10.8%
5:00 PM	344	37	381	90.3%	9.7%
6:00 PM	374	32	406	92.1%	7.9%
7:00 PM	311	18	329	94.5%	5.5%
8:00 PM	217	30	247	87.9%	12.1%
9:00 PM	172	31	203	84.7%	15.3%
10:00 PM	124	23	147	84.4%	15.6%
11:00 PM	72	13	85	84.7%	15.3%
12:00 AM	52	11	63	82.5%	17.5%
24-Hour	4159	779	4938	84.2%	15.8%
6:00a- 8:30a	500	105	605	82.6%	17.4%
11:00a- 1:30p	552	122	674	81.9%	18.1%
3:30p - 6:00p	892	90	982	90.8%	9.2%

FIGURE A.06 : Inbound Vehicle Class Counts and Percentages at Station 4 IN

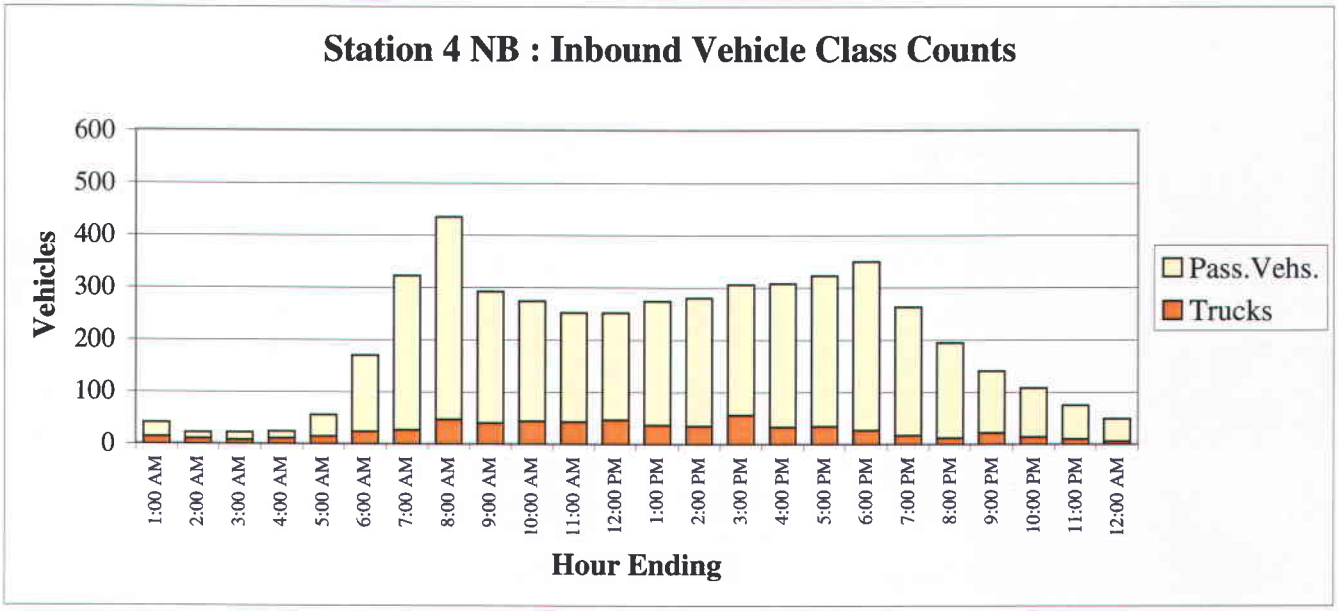
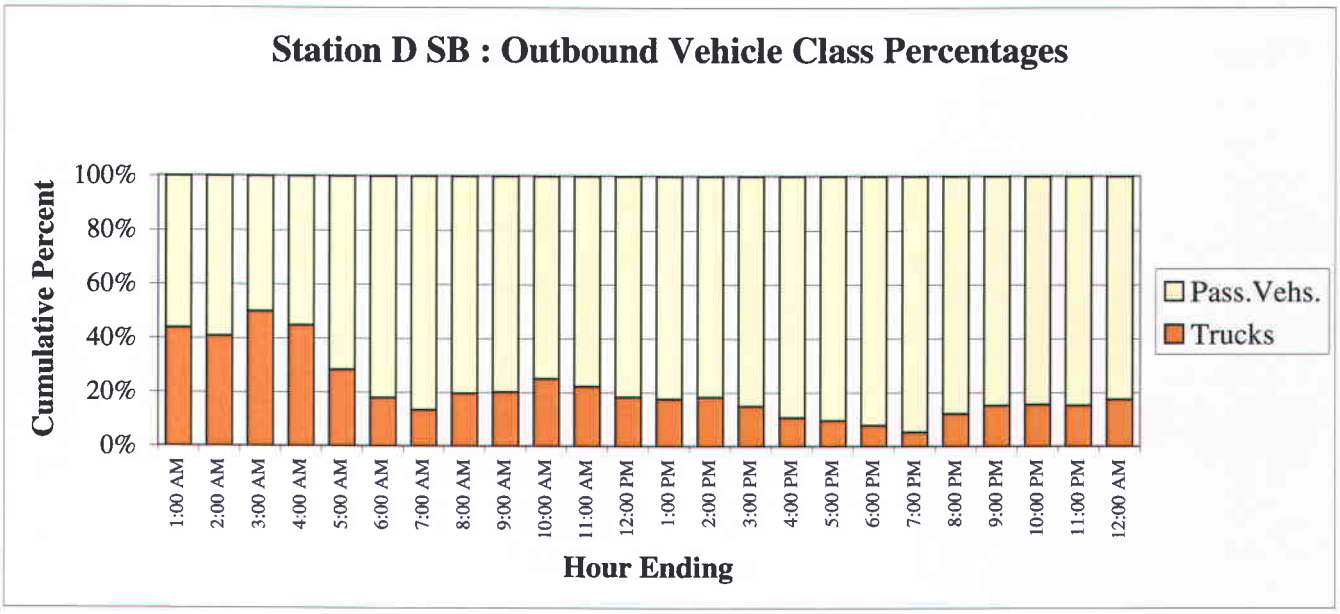
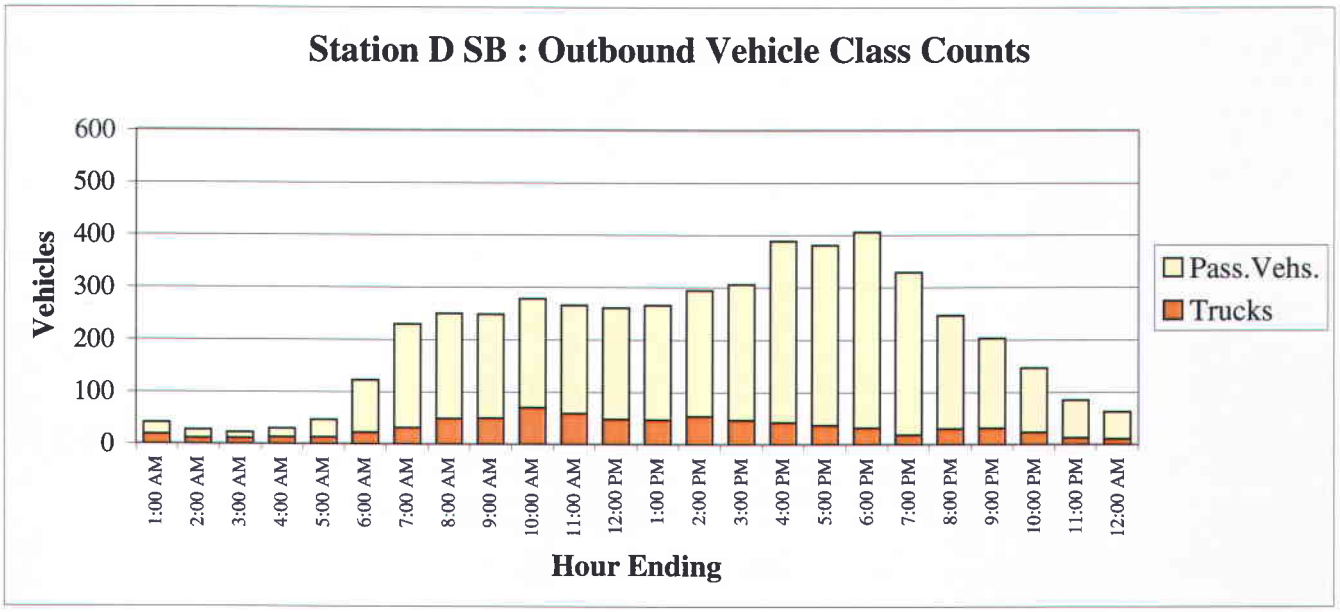


FIGURE A.07 : Outbound Vehicle Class Counts and Percentages at Station D OUT





As stated previously in this chapter, the pattern of origins and destinations for heavy vehicle through trips using the SR 9 corridor is different from the patterns for passenger vehicles. This fact, combined with the time-of-day volume differences between heavy vehicles and passenger vehicles, was the basis for the decision to disaggregate vehicle types in the subsequent task of applying peak hour through trip characteristics to an expanded 24-hour estimate.

In addition to evaluation of the INDOT classification counts themselves, peak hour data were entered into a standard INDOT worksheet used to determine axle adjustment factors and heavy vehicle percentages. When calculated using vehicle classification counts, axle correction factors provide a standardized method for correcting mechanical vehicle overcounts attributed to the excess number of axles on heavy vehicles.

In the tables that follow, the sum of the column labeled *Actual Volume* can be multiplied by the calculated *Axle Correction Factor (ACF)* to yield an adjusted total volume. The calculated *% Heavy Vehicles (%HV)* can then be applied to the adjusted total volume to determine the adjusted total number of heavy vehicles and passenger vehicles.

Table A.14 shows Axle Correction Factor calculations for a full 24-hours at the four stations where vehicle classification count data were available. Tables A.15, A.16, and A.17 show the calculations for the 2.5-hour AM, PM, and Mid-Day survey periods, respectively.

TABLE A.14 : Axle Correction Factor Worksheet – 24-Hour Vehicle Data

Location: SR 9 at CR 500 N [Inbound]

Sta.1 IN southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	3	0	0	3
2	830	0	0	830
3	264	0	0	264
4	0	0	0	0
5	18	0	0	18
6	1	0.5	0.5	1.5
7	5	1	5	10
8	12	1	12	24
9	40	1.5	60	100
10	0	2	0	0
11	2	1.5	3	5
12	24	2	48	72
13	1	2.5	2.5	3.5
Totals:	1,200			1,331

Axle Correction Factor = 0.902 %HV = 8.6%

Location: SR 9 at CR 500 N [Outbound]

Sta.A OUT northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	5	0	0	5
2	473	0	0	473
3	176	0	0	176
4	0	0	0	0
5	26	0	0	26
6	18	0.5	9	27
7	0	1	0	0
8	5	1	5	10
9	40	1.5	60	100
10	1	2	2	3
11	0	1.5	0	0
12	8	2	16	24
13	0	2.5	0	0
Totals:	752			844

Axle Correction Factor = 0.891 %HV = 13.0%

Location: SR 9 at White Oak [Inbound]

Sta.4 IN northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	2	0	0	2
2	581	0	0	581
3	226	0	0	226
4	1	0	0	1
5	14	0	0	14
6	16	0.5	8	24
7	6	1	6	12
8	6	1	6	12
9	51	1.5	76.5	127.5
10	1	2	2	3
11	0	1.5	0	0
12	1	2	2	3
13	0	2.5	0	0
Totals:	905			1,006

Axle Correction Factor = 0.900 %HV = 10.6%

Location: SR 9 at White Oak [Outbound]

Sta.D OUT southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	4	0	0	4
2	352	0	0	352
3	144	0	0	144
4	0	0	0	0
5	15	0	0	15
6	13	0.5	6.5	19.5
7	4	1	4	8
8	12	1	12	24
9	61	1.5	91.5	152.5
10	0	2	0	0
11	0	1.5	0	0
12	1	2	2	3
13	0	2.5	0	0
Totals:	606			722

Axle Correction Factor = 0.839 %HV = 17.5%

TABLE A.15 : Axle Correction Factor Worksheet – 2.5-Hour AM Vehicle Data

Location: SR 9 at CR 500 N [Inbound]

Sta.1 IN southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	33	0	0	33
2	3744	0	0	3744
3	1212	0	0	1212
4	3	0	0	3
5	84	0	0	84
6	36	0.5	18	54
7	72	1	72	144
8	66	1	66	132
9	391	1.5	586.5	977.5
10	5	2	10	15
11	4	1.5	6	10
12	98	2	196	294
13	4	2.5	10	14
Totals:	5,752			6,717

Axle Correction Factor = 0.856 %HV = 13.3%

Location: SR 9 at CR 500 N [Outbound]

Sta.A OUT northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	47	0	0	47
2	3820	0	0	3820
3	1175	0	0	1175
4	2	0	0	2
5	97	0	0	97
6	163	0.5	81.5	244.5
7	4	1	4	8
8	44	1	44	88
9	386	1.5	579	965
10	6	2	12	18
11	4	1.5	6	10
12	39	2	78	117
13	1	2.5	2.5	3.5
Totals:	5,788			6,595

Axle Correction Factor = 0.878 %HV = 12.9%

Location: SR 9 at White Oak [Inbound]

Sta.4 IN northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	26	0	0	26
2	3074	0	0	3074
3	1102	0	0	1102
4	3	0	0	3
5	63	0	0	63
6	62	0.5	31	93
7	25	1	25	50
8	47	1	47	94
9	420	1.5	630	1050
10	5	2	10	15
11	1	1.5	1.5	2.5
12	5	2	10	15
13	1	2.5	2.5	3.5
Totals:	4,834			5,591

Axle Correction Factor = 0.865 %HV = 13.1%

Location: SR 9 at White Oak [Outbound]

Sta.D OUT southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	18	0	0	18
2	3021	0	0	3021
3	1120	0	0	1120
4	5	0	0	5
5	76	0	0	76
6	77	0.5	38.5	115.5
7	16	1	16	32
8	82	1	82	164
9	504	1.5	756	1260
10	7	2	14	21
11	0	1.5	0	0
12	9	2	18	27
13	3	2.5	7.5	10.5
Totals:	4,938			5,870

Axle Correction Factor = 0.841 %HV = 15.8%

TABLE A.16 : Axle Correction Factor Worksheet – 2.5-Hour PM Vehicle Data

Location: SR 9 at CR 500 N [Inbound]

Sta.1 IN southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	9	0	0	9
2	613	0	0	613
3	219	0	0	219
4	1	0	0	1
5	15	0	0	15
6	9	0.5	4.5	13.5
7	10	1	10	20
8	8	1	8	16
9	60	1.5	90	150
10	0	2	0	0
11	0	1.5	0	0
12	10	2	20	30
13	1	2.5	2.5	3.5
Totals:	955			1,090

Axle Correction Factor = 0.876

%HV = 11.9%

Location: SR 9 at CR 500 N [Outbound]

Sta.A OUT northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	14	0	0	14
2	949	0	0	949
3	249	0	0	249
4	0	0	0	0
5	17	0	0	17
6	14	0.5	7	21
7	2	1	2	4
8	7	1	7	14
9	54	1.5	81	135
10	1	2	2	3
11	1	1.5	1.5	2.5
12	5	2	10	15
13	0	2.5	0	0
Totals:	1,313			1,424

Axle Correction Factor = 0.922

%HV = 7.7%

Location: SR 9 at White Oak [Inbound]

Sta.4 IN northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	8	0	0	8
2	558	0	0	558
3	185	0	0	185
4	1	0	0	1
5	9	0	0	9
6	7	0.5	3.5	10.5
7	3	1	3	6
8	5	1	5	10
9	54	1.5	81	135
10	1	2	2	3
11	0	1.5	0	0
12	0	2	0	0
13	0	2.5	0	0
Totals:	831			926

Axle Correction Factor = 0.898

%HV = 9.6%

Location: SR 9 at White Oak [Outbound]

Sta.D OUT southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	5	0	0	5
2	645	0	0	645
3	242	0	0	242
4	0	0	0	0
5	7	0	0	7
6	10	0.5	5	15
7	3	1	3	6
8	11	1	11	22
9	58	1.5	87	145
10	1	2	2	3
11	0	1.5	0	0
12	1	2	2	3
13	1	2.5	2.5	3.5
Totals:	984			1,097

Axle Correction Factor = 0.897

%HV = 9.3%

TABLE A.17 : Axle Correction Factor Worksheet – 2.5-Hour Mid-Day Vehicle Data

Location: SR 9 at CR 500 N [Inbound]

Sta.1 IN southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	0	0	0	0
2	457	0	0	457
3	142	0	0	142
4	0	0	0	0
5	9	0	0	9
6	5	0.5	2.5	7.5
7	24	1	24	48
8	8	1	8	16
9	60	1.5	90	150
10	2	2	4	6
11	0	1.5	0	0
12	7	2	14	21
13	0	2.5	0	0
Totals:	714			857

Axle Correction Factor = 0.834 %HV = 16.1%

Location: SR 9 at CR 500 N [Outbound]

Sta.A OUT northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	6	0	0	6
2	476	0	0	476
3	149	0	0	149
4	1	0	0	1
5	14	0	0	14
6	48	0.5	24	72
7	1	1	1	2
8	9	1	9	18
9	58	1.5	87	145
10	1	2	2	3
11	0	1.5	0	0
12	7	2	14	21
13	0	2.5	0	0
Totals:	770			907

Axle Correction Factor = 0.849 %HV = 18.1%

Location: SR 9 at White Oak [Inbound]

Sta.4 IN northbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	3	0	0	3
2	401	0	0	401
3	162	0	0	162
4	0	0	0	0
5	6	0	0	6
6	13	0.5	6.5	19.5
7	5	1	5	10
8	11	1	11	22
9	63	1.5	94.5	157.5
10	1	2	2	3
11	0	1.5	0	0
12	3	2	6	9
13	0	2.5	0	0
Totals:	668			793

Axle Correction Factor = 0.842 %HV = 15.3%

Location: SR 9 at White Oak [Outbound]

Sta.D OUT southbound

Class	Actual Volume	Excess Vehicles	Excess Axles	Act.Volume + Excess Axles
1	0	0	0	0
2	387	0	0	387
3	165	0	0	165
4	0	0	0	0
5	18	0	0	18
6	12	0.5	6	18
7	1	1	1	2
8	11	1	11	22
9	77	1.5	115.5	192.5
10	1	2	2	3
11	0	1.5	0	0
12	3	2	6	9
13	1	2.5	2.5	3.5
Totals:	676			820

Axle Correction Factor = 0.824 %HV = 18.3%

This series of worksheets reveals an important validation of previous comments regarding the time of day variations in heavy vehicle percentages of the SR 9 traffic volumes. Axle correction factors average roughly 0.9 in the AM and PM periods when passenger vehicle percentages of the traffic streams are highest. During the mid-day, when heavy vehicle percentages are relatively higher, axle correction factors are slightly above 0.8 as a consequence of the number of vehicles with more than two axles. On the 24-hour worksheet, an average axle correction factors in the mid-range between 0.8 and 0.9 confirm that, on a daily basis, passenger vehicles comprise most of the SR 9 traffic stream.

Moreover, there is a logical consistency between the worksheets. This characteristic supports the use of these axle correction factors, based on available vehicle classification data, to adjust the raw mechanical vehicle counts at other stations. In the absence of vehicle classification counts at all stations along the SR 9 corridor, the validity of such adjustments is an important element in the expansion of peak period through traffic distributions to estimated daily distributions of through trips.

Synthesis and Validation of License Plate Survey and Vehicle Count Data

Previous sections of this chapter have described the methods for collecting and assembling the data needed to develop daily through trip estimates for the SR 9 corridor. License plate data consisted of a temporal sampling [5 hours out of 24 for autos; 2.5 hours out of 24 for trucks], while vehicle classification counts were conducted continuously at only 4 of 12 vehicle count locations. This section will discuss the methodology and results of the effort to assemble the data in a unified form for direct application in the expansion of the sampled data into a 24-hour format.

As noted in earlier sections of this chapter [See Evaluation of Weekday Through Trip Characteristics], the work program selected by PKG and PIC was based upon a determination that separate estimates of passenger vehicles and heavy vehicles in relationship to overall traffic volumes would have to be developed. The following discussion will explain how these estimates were created and will identify both similarities and differences between the procedures used for the two vehicle types.

Passenger Vehicle Estimation Procedure

Previously described Table A.06 showed the sums of adjusted passenger vehicles and total vehicles during the AM and PM license plate survey periods. With slight rounding differences attributed to matrix balancing operations, these volumes are repeated in Table A.18 along with the nominal INDOT mechanical counts for the survey periods.

Estimated (600-830) AM and (330-600) PM vehicle counts were adjusted by multiplying the [*nominal value*] x [*Axle Correction Factor*] x [*100% - % Heavy Vehicles*] for autos, and [*nominal value*] x [*Axle Correction Factor*] x [*% Heavy Vehicles*] for trucks. *Calculated Autos* and *Calculated Trucks* are added to give the *Adjusted Total Vehicle Count*. An axle correction factor of 0.891, used for the eight stations lacking vehicle classification count data, is the average ACF calculated from the four stations with classification counts.

The *Survey/Auto Ratio* equals *LPS Vehicles* divided by *Calculated Autos*; *LPS Through* vehicles divided by this ratio yields *Adjusted Through Autos*. Use of this ratio indexes the number of auto through trips directly to the refined estimates of total auto traffic.

Adjusted Through Percent equals *Adjusted Through Autos* divided by *Calculated Autos*. This value may be compared to the preliminary time- and volume-expanded through vehicle percentages appearing in Table A.07 (a) and (b).

The ratio [*AVC*]/[*MVC*] is the *Adjusted Total Vehicle Count* divided by the *Estimated Mechanical Vehicle Count* and is a comparable to the given *Axle Correction Factor*.

Calculated Percent Autos or *Percent Trucks* equal *Calculated Autos* or *Calculated Percent Trucks* divided by the *Adjusted Total Vehicle Count* and may be compared to the given *INDOT Percent Trucks*. *INDOT Percent Trucks* were calculated and checked against INDOT data at the four stations with vehicle classification counts; values at the remaining eight stations are estimates developed by review of the classification counts and field observation.

As noted in the two preceding paragraphs, Table A.18 includes comparison calculations used to monitor and test the validity of the procedures described.

TABLE A.18 : Final Estimate of AM and PM Autos, Trucks, Total Vehicles and Through Autos

Station ID	LPS Vehicles	LPS Through	*[MVC]** Estimated Mech.Veh 600-830	*[AVC]** Adjusted Total.Veh Count	Survey / Auto Ratio	Adjusted Through **Autos**	Adjusted Through **Percent**	Ratio *[AVC]* / *[MVC]*	Axle Corr.Fac. [ACF]	INDOT Percent Trucks	Calculated **Trucks**	Calculated **Autos**	Calculated **Percent Trucks**	Calculated **Percent Autos**
AM 1 in	971	167	1197	**1080**	0.984	**170**	17.2%	0.902	0.902	8.6%	93	987	8.6%	91.4%
AM 2 in	697	29	1041	**927**	0.854	**34**	4.2%	0.890	0.891	12.0%	111	816	12.0%	88.0%
AM 3 in	1151	47	1198	**1067**	1.135	**41**	4.0%	0.891	0.891	5.0%	53	1014	5.0%	95.0%
AM 4 in	874	91	903	**813**	1.202	**76**	10.5%	0.900	0.900	10.6%	86	727	10.6%	89.4%
AM 5 in	943	93	1191	**1061**	0.955	**97**	9.8%	0.891	0.891	7.0%	74	987	7.0%	93.0%
AM 6 in	366	15	528	**470**	0.884	**17**	4.1%	0.890	0.891	12.0%	56	414	11.9%	88.1%
AM A out	713	84	751	**669**	1.225	**69**	11.9%	0.891	0.891	13.0%	87	582	13.0%	87.0%
AM B out	2332	198	2837	**2527**	1.049	**189**	8.5%	0.891	0.891	12.0%	303	2224	12.0%	88.0%
AM C out	1081	74	1204	**1073**	1.083	**68**	6.8%	0.891	0.891	7.0%	75	998	7.0%	93.0%
AM D out	565	25	605	**508**	1.348	**19**	4.5%	0.840	0.839	17.5%	89	419	17.5%	82.5%
AM E out	456	39	545	**485**	0.989	**39**	8.5%	0.890	0.891	5.0%	24	461	4.9%	95.1%
AM F out	334	22	466	**415**	0.915	**24**	6.6%	0.891	0.891	12.0%	50	365	12.0%	88.0%
PM 1 in	769	116	955	**837**	1.043	**111**	15.1%	0.876	0.876	11.9%	100	737	11.9%	88.1%
PM 2 in	2474	318	2505	**2232**	1.205	**264**	12.9%	0.891	0.891	8.0%	179	2053	8.0%	92.0%
PM 3 in	1788	148	1986	**1769**	1.064	**139**	8.3%	0.891	0.891	5.0%	88	1681	5.0%	95.0%
PM 4 in	819	109	827	**742**	1.221	**89**	13.3%	0.897	0.898	9.6%	71	671	9.6%	90.4%
PM 5 in	737	80	954	**851**	0.932	**86**	10.9%	0.892	0.891	7.0%	60	791	7.1%	92.9%
PM 6 in	378	31	511	**456**	0.943	**33**	8.2%	0.892	0.891	12.0%	55	401	12.1%	87.9%
PM A out	1323	367	1311	**1209**	1.185	**310**	27.8%	0.922	0.922	7.7%	93	1116	7.7%	92.3%
PM B out	1083	92	1357	**1209**	1.018	**90**	8.5%	0.891	0.891	12.0%	145	1064	12.0%	88.0%
PM C out	1576	96	1610	**1435**	1.156	**83**	6.1%	0.891	0.891	5.0%	72	1363	5.0%	95.0%
PM D out	913	80	982	**881**	1.143	**70**	8.8%	0.897	0.897	9.3%	82	799	9.3%	90.7%
PM E out	1068	144	1203	**1072**	1.071	**134**	13.4%	0.891	0.891	7.0%	75	997	7.0%	93.0%
PM F out	469	23	634	**565**	0.944	**24**	4.8%	0.891	0.891	12.0%	68	497	12.0%	88.0%

Heavy Vehicle Estimation Procedure

Estimates of heavy vehicle totals and through trips were refined using a similar spreadsheet method described for passenger vehicles. Table A.19 is adapted from the working spreadsheet in which the notation "truck" is substituted for "heavy vehicle" for the conservation of space. Any references to "trucks" are equally representative of trucks or buses.

It is important to re-emphasize that the mid-day license plate survey collected data only on heavy vehicles, not on passenger vehicles. Mechanical volume and vehicle classification counts were based on all vehicles. Therefore, consistency of methodology required recalculation of heavy vehicles and passenger vehicles to derive adjusted total vehicles and the relationship of that value to through heavy vehicle trips.

Previously described Table A.09 showed the sums of adjusted heavy vehicle through trips and total heavy vehicles during the mid-day license plate survey period. These volumes are repeated in Table A.19 along with the nominal INDOT mechanical count for that survey period.

Estimated (1100AM-130PM) total vehicle counts were adjusted by multiplying the [*nominal value*] x [*Axle Correction Factor*] x [*100% - % Heavy Vehicles*] for autos, and [*nominal value*] x [*Axle Correction Factor*] x [*% Heavy Vehicles*] for trucks. *Calculated Autos* and *Calculated Trucks* are added to give the *Adjusted Total Vehicle Count*. Estimated axle correction factors of 0.838 (inbound stations) and 0.837 (outbound stations), used for the eight stations lacking vehicle classification count data, are averages for directional ACFs calculated from the four stations with classification counts.

The *Survey/Truck Ratio* equals *LPS Total Trucks* divided by *Calculated Trucks*; *LPS Through* vehicles divided by this ratio yields *Adjusted Through Trucks*. Recall that the mid-day survey counted only heavy vehicles. The Survey/Truck ratio is used to index the number of through truck trips directly to the refined estimates of total vehicles, as opposed to total heavy vehicles.

Adjusted Through Percent equals *Adjusted Through Trucks* divided by *Calculated Trucks*. This value may be compared to the preliminary volume-expanded through vehicle percentages appearing in Table A.09.

Calculated Percent Autos or *Percent Trucks* equal *Calculated Autos* or *Calculated Percent Trucks* divided by the *Adjusted Total Vehicle Count* and may be compared to the given *INDOT Percent Trucks*. *INDOT Percent Trucks* were calculated and checked against INDOT data at the four stations with vehicle classification counts. In contrast to the passenger vehicle procedure, *INDOT Percent Trucks* values at the remaining eight stations were trial-and-error estimates adjusted to bring respective *Survey/Truck Ratios* into the range of values calculated for the stations with INDOT vehicle classification data.

As noted in the two preceding paragraphs, Table A.19 includes comparison calculations used to monitor and test the validity of the procedures described.

TABLE A.19 : Final Estimate of Mid-Day Autos, Trucks, Total Vehicles and Through Trucks

Station ID	LPS Total **Trucks**	LPS Through **Trucks**	Estimated **Mech.Veh** 600-830	Adjusted **Total.Veh** Count	Survey / Truck Ratio	Adjusted Through **Trucks**	Adjusted Through **Percent**	Axle Corr.Fac. [ACF]	INDOT Percent Trucks	Calculated **Trucks**	Calculated **Autos**	Calculated **Percent** **Trucks**	Calculated **Percent** **Autos**
MD 1 in	82	24	711	**593**	0.863	**28**	29.5%	0.834	16.1%	95	498	16.0%	84.0%
MD 2 in	120	21	1126	**944**	0.845	**25**	17.6%	0.838	15.0%	142	802	15.0%	85.0%
MD 3 in	57	6	1215	**1018**	0.864	**7**	10.6%	0.838	6.5%	66	952	6.5%	93.5%
MD 4 in	73	31	666	**561**	0.849	**37**	43.0%	0.842	15.3%	86	475	15.3%	84.7%
MD 5 in	56	23	951	**797**	0.824	**28**	41.2%	0.838	8.5%	68	729	8.5%	91.5%
MD 6 in	43	18	447	**374**	0.827	**22**	42.3%	0.838	14.0%	52	322	13.9%	86.1%
MD A out	127	42	768	**652**	1.076	**39**	33.1%	0.849	18.1%	118	534	18.1%	81.9%
MD B out	106	16	1121	**938**	1.029	**16**	15.5%	0.837	11.0%	103	835	11.0%	89.0%
MD C out	56	15	1216	**1018**	1.098	**14**	27.5%	0.837	5.0%	51	967	5.0%	95.0%
MD D out	124	37	674	**556**	1.216	**30**	29.4%	0.824	18.3%	102	454	18.3%	81.7%
MD E out	22	10	737	**617**	1.000	**10**	45.5%	0.837	3.5%	22	595	3.6%	96.4%
MD F out	19	3	486	**406**	1.056	**3**	16.7%	0.837	4.5%	18	388	4.4%	95.6%

Application of Calculated Sample Parameters to 24-Hour Data

Based on the evaluation of Tables A.18 and A.19, relationships between vehicle classification counts and axle correction factors appear to be reasonably consistent within the sampled license plate survey and classification data despite differences attributable to vehicle types. Determining this logical consistency allows uniform application of the calculated parameters to the 24-hour vehicle count data.

Table A.14 described earlier in this chapter shows the calculated axle correction factors and percent heavy vehicles using the full 24-hour vehicle classification counts at four of the twelve SR 9 corridor stations. Results from this worksheet were re-evaluated with respect to the cumulative information assembled during the testing of the sampled data. The final procedural decision organizes the 24-hour vehicle counts by inbound and outbound directions separately for passenger vehicles and heavy vehicles.

Tables A.20 through A.23 display the worksheets used to calculate directional 24-hour passenger and heavy vehicle volumes for all stations on the perimeter of the SR 9 corridor. The left half of each worksheet shows the hourly traffic volumes for six respective inbound or outbound stations. The right half displays the calculated hourly passenger vehicle or heavy vehicle values resulting from the axle correction and vehicle type percentage factors used for each station. 24-hour total vehicles are the sums of hourly calculations.

In the spreadsheet procedure, passenger vehicle percentages (see Tables A.20, A.21) were selected first. Counterpart heavy vehicle percentages were constrained by the following logical requirement :

X% autos + Y% trucks = 100% total vehicles;
If X% autos are determined first, then Y% trucks must = (100% - X%)

Tables A.22 and A.23 show independently calculated, or unconstrained, heavy vehicle axle correction and heavy vehicle percentage factors for the purpose of comparison to the constrained factors used. Differences between these factors support the argument that the through trip estimation methodology has not overestimated the percentage of heavy vehicles.

In each of these four tables adjusted 24-hour total volumes by specified vehicle type provide the station control totals subsequently used to develop the 24-hour through trip matrices.

Table A.20 shows adjusted 24-hour *inbound* volumes for passenger vehicles (stations 1–6);
Table A.21 shows adjusted 24-hour *outbound* volumes for passenger vehicles (stations A–F);
Table A.22 shows adjusted 24-hour *inbound* volumes for heavy vehicles (stations 1–6);
Table A.23 shows adjusted 24-hour *outbound* volumes for heavy vehicles (stations A–F).

Table A.20 : Calculation of 24-Hour Inbound Passenger Vehicles

Unadjusted INDOT Mechanical Vehicle Counts

Hour Ending	LPS 1 in 60 SB	LPS 2 in 41 EB off	LPS 3 in 70 EB	LPS 4 in 10 NB	LPS 5 in 80 WB	LPS 6 in 43 WB off	Total IN
1:00 AM	43	87	42	41	67	40	320
2:00 AM	21	72	35	22	15	15	180
3:00 AM	25	40	14	22	23	27	151
4:00 AM	27	58	23	24	38	19	189
5:00 AM	67	98	28	56	64	85	398
6:00 AM	245	195	123	170	206	173	1112
7:00 AM	448	357	397	322	466	235	2225
8:00 AM	565	460	570	435	512	216	2758
9:00 AM	368	448	462	292	425	154	2149
10:00 AM	307	397	405	274	346	173	1902
11:00 AM	289	366	415	252	353	176	1851
12:00 PM	274	434	422	252	365	186	1933
1:00 PM	286	452	508	274	386	159	2065
2:00 PM	302	479	569	280	399	203	2232
3:00 PM	380	611	593	306	405	201	2496
4:00 PM	381	809	692	308	390	187	2767
5:00 PM	372	1027	799	323	432	193	3146
6:00 PM	392	1073	841	350	327	224	3207
7:00 PM	281	694	610	263	352	122	2322
8:00 PM	228	449	393	195	254	110	1629
9:00 PM	188	331	358	141	182	129	1329
10:00 PM	127	315	258	108	158	91	1057
11:00 PM	94	192	108	75	87	96	652
12:00 AM	42	133	84	49	40	30	378
24-Hour	**5752**	**9577**	**8749**	**4834**	**6292**	**3244**	**38448**
6:00a- 8:30a	1197	1041	1198	903	1191	528	6058
3:30p - 6:00p	955	2505	1986	827	954	511	7737
LPS- 5Hr	**2152**	**3546**	**3184**	**1730**	**2145**	**1039**	**13795**
% of 24-Hr	37.4%	37.0%	36.4%	35.8%	34.1%	32.0%	35.9%
Remain-19Hr	**3600**	**6031**	**5565**	**3104**	**4147**	**2205**	**24653**
% of 24-Hr	62.6%	63.0%	63.6%	64.2%	65.9%	68.0%	64.1%

Axle Adjusted INDOT Mechanical Counts : Inbound Passenger Vehicles

Axle.Corr.Fact.		0.856	0.861	0.861	0.865	0.861	0.861	
Pct.Pass.Veh.		86.7%	86.8%	86.8%	86.9%	86.8%	86.8%	
Hour Ending		LPS 1 in 60 SB	LPS 2 in 41 EB off	LPS 3 in 70 EB	LPS 4 in 10 NB	LPS 5 in 80 WB	LPS 6 in 43 WB off	Total IN
1:00 AM		32	65	31	31	50	30	239
2:00 AM		16	54	26	17	11	11	135
3:00 AM		19	30	10	17	17	20	113
4:00 AM		20	43	17	18	28	14	140
5:00 AM		50	73	21	42	48	64	298
6:00 AM		182	146	92	128	154	129	831
7:00 AM		332	267	297	242	348	176	1662
8:00 AM		419	344	426	327	383	161	2060
9:00 AM		273	335	345	219	318	115	1605
10:00 AM		228	297	303	206	259	129	1422
11:00 AM		214	274	310	189	264	132	1383
12:00 PM		203	324	315	189	273	139	1443
1:00 PM		212	338	380	206	288	119	1543
2:00 PM		224	358	425	210	298	152	1667
3:00 PM		282	457	443	230	303	150	1865
4:00 PM		283	605	517	232	291	140	2068
5:00 PM		276	768	597	243	323	144	2351
6:00 PM		291	802	629	263	244	167	2396
7:00 PM		209	519	456	198	263	91	1736
8:00 PM		169	336	294	147	190	82	1218
9:00 PM		140	247	268	106	136	96	993
10:00 PM		94	235	193	81	118	68	789
11:00 PM		70	143	81	56	65	72	487
12:00 AM		31	99	63	37	30	22	282
24-Hour		**4269**	**7159**	**6539**	**3634**	**4702**	**2423**	**28726**
6:00a- 8:30a		888	779	896	679	890	395	4525
3:30p - 6:00p		709	1873	1485	622	713	381	5781
LPS- 5Hr		**1597**	**2652**	**2381**	**1301**	**1603**	**776**	**10306**
% of 24-Hr		37.4%	37.0%	36.4%	35.8%	34.1%	32.0%	35.9%
Remain-19Hr		**2672**	**4507**	**4158**	**2333**	**3099**	**1647**	**18420**
% of 24-Hr		62.6%	63.0%	63.6%	64.2%	65.9%	68.0%	64.1%

Table A.21 : Calculation of 24-Hour Outbound Passenger Vehicles

Unadjusted INDOT Mechanical Vehicle Counts

Hour Ending	LPS A out 60 NB	LPS B out 44 WB on	LPS C out 70 WB	LPS D out 10 SB	LPS E out 80 EB	LPS F out 42 EB on	Total OUT
1:00 AM	53	94	28	41	37	64	317
2:00 AM	30	41	14	27	33	36	181
3:00 AM	19	41	18	22	13	23	136
4:00 AM	28	80	31	29	23	24	215
5:00 AM	35	164	73	46	20	49	387
6:00 AM	91	537	223	123	34	86	1094
7:00 AM	231	1187	417	230	165	142	2372
8:00 AM	370	1315	556	250	282	222	2995
9:00 AM	299	670	461	249	195	203	2077
10:00 AM	248	479	424	278	229	166	1824
11:00 AM	259	503	444	266	261	194	1927
12:00 PM	280	421	476	261	281	168	1887
1:00 PM	334	450	506	266	295	212	2063
2:00 PM	307	500	468	294	322	212	2103
3:00 PM	398	553	537	306	375	191	2360
4:00 PM	530	598	685	389	465	305	2972
5:00 PM	571	530	725	381	523	258	2988
6:00 PM	475	528	542	406	447	223	2621
7:00 PM	400	412	469	329	380	164	2154
8:00 PM	262	273	338	247	258	126	1504
9:00 PM	242	235	273	203	194	125	1272
10:00 PM	146	165	166	147	142	81	847
11:00 PM	76	144	104	85	90	65	564
12:00 AM	104	96	54	63	83	105	505
24-Hour	**5788**	**10016**	**8032**	**4938**	**5147**	**3444**	**37365**
6:00a- 8:30a	751	2837	1204	605	545	466	6406
3:30p - 6:00p	1311	1357	1610	982	1203	634	7095
LPS- 5Hr	**2062**	**4194**	**2814**	**1587**	**1748**	**1100**	**13501**
% of 24-Hr	35.6%	41.9%	35.0%	32.1%	34.0%	31.9%	36.1%
Remain-19Hr	**3726**	**5822**	**5218**	**3351**	**3399**	**2344**	**23864**
% of 24-Hr	64.4%	58.1%	65.0%	67.9%	66.0%	68.1%	63.9%

Axle Adjusted INDOT Mechanical Counts : Outbound Passenger Vehicles

Axle.Corr.Fact.	**0.878**	**0.860**	**0.860**	**0.841**	**0.860**	**0.860**	
Pct.Pass.Veh.	**87.1%**	**85.6%**	**85.6%**	**84.2%**	**85.6%**	**85.6%**	
Hour Ending	LPS A out 60 NB	LPS B out 44 WB on	LPS C out 70 WB	LPS D out 10 SB	LPS E out 80 EB	LPS F out 42 EB on	Total OUT
1:00 AM	41	69	21	29	27	47	234
2:00 AM	23	30	10	19	24	27	133
3:00 AM	15	30	13	16	10	17	101
4:00 AM	21	59	23	21	17	18	159
5:00 AM	27	121	54	33	15	36	286
6:00 AM	70	395	164	87	25	63	804
7:00 AM	177	874	307	163	121	105	1747
8:00 AM	283	968	409	177	208	163	2208
9:00 AM	229	493	339	176	144	149	1530
10:00 AM	190	353	312	197	169	122	1343
11:00 AM	198	370	327	188	192	143	1418
12:00 PM	214	310	350	185	207	124	1390
1:00 PM	255	331	372	188	217	156	1519
2:00 PM	235	368	345	208	237	156	1549
3:00 PM	304	407	395	217	276	141	1740
4:00 PM	405	440	504	275	342	225	2191
5:00 PM	437	390	534	270	385	190	2206
6:00 PM	363	389	399	287	329	164	1931
7:00 PM	306	303	345	233	280	121	1588
8:00 PM	200	201	249	175	190	93	1108
9:00 PM	185	173	201	144	143	92	938
10:00 PM	112	121	122	104	105	60	624
11:00 PM	58	106	77	60	66	48	415
12:00 AM	80	71	40	45	61	77	374
24-Hour	**4428**	**7372**	**5912**	**3497**	**3790**	**2537**	**27536**
6:00a- 8:30a	575	2089	886	428	401	343	4720
3:30p - 6:00p	1003	999	1185	695	885	467	5233
LPS- 5Hr	**1578**	**3088**	**2071**	**1123**	**1286**	**810**	**9953**
% of 24-Hr	35.6%	41.9%	35.0%	32.1%	33.9%	31.9%	36.1%
Remain-19Hr	**2850**	**4284**	**3841**	**2374**	**2504**	**1727**	**17583**
% of 24-Hr	64.4%	58.1%	65.0%	67.9%	66.1%	68.1%	63.9%

Table A.22 : Calculation of 24-Hour Inbound Heavy Vehicles

Unadjusted INDOT Mechanical Vehicle Counts

Hour Ending	LPS 1 in 60 SB	LPS 2 in 41 EB off	LPS 3 in 70 EB	LPS 4 in 10 NB	LPS 5 in 80 WB	LPS 6 in 43 WB off	Total IN
1:00 AM	43	87	42	41	67	40	320
2:00 AM	21	72	35	22	15	15	180
3:00 AM	25	40	14	22	23	27	151
4:00 AM	27	58	23	24	38	19	189
5:00 AM	67	98	28	56	64	85	398
6:00 AM	245	195	123	170	206	173	1112
7:00 AM	448	357	397	322	466	235	2225
8:00 AM	565	460	570	435	512	216	2758
9:00 AM	368	448	462	292	425	154	2149
10:00 AM	307	397	405	274	346	173	1902
11:00 AM	289	366	415	252	353	176	1851
12:00 PM	274	434	422	252	365	186	1933
1:00 PM	286	452	508	274	386	159	2065
2:00 PM	302	479	569	280	399	203	2232
3:00 PM	380	611	593	306	405	201	2496
4:00 PM	381	809	692	308	390	187	2767
5:00 PM	372	1027	799	323	432	193	3146
6:00 PM	392	1073	841	350	327	224	3207
7:00 PM	281	694	610	263	352	122	2322
8:00 PM	228	449	393	195	254	110	1629
9:00 PM	188	331	358	141	182	129	1329
10:00 PM	127	315	258	108	158	91	1057
11:00 PM	94	192	108	75	87	96	652
12:00 AM	42	133	84	49	40	30	378
24-Hour	**5752**	**9577**	**8749**	**4834**	**6292**	**3244**	**38448**
11:00a- 1:30p	1197	1041	1198	903	1191	528	6058
	955	2505	1986	827	954	511	7737
LPS: 2.5Hr	**2152**	**3546**	**3184**	**1730**	**2145**	**1039**	**13795**
% of 24-Hr	37.4%	37.0%	36.4%	35.8%	34.1%	32.0%	35.9%
Remain-19Hr	**3600**	**6031**	**5565**	**3104**	**4147**	**2205**	**24653**
% of 24-Hr	62.6%	63.0%	63.6%	64.2%	65.9%	68.0%	64.1%

Axle Adjusted INDOT Mechanical Counts : Inbound Heavy Vehicles

Axle.Corr.Fact.	**0.856**	**0.861**	**0.861**	**0.865**	**0.861**	**0.861**	
Pct.Trucks	**13.3%**	**13.2%**	**13.2%**	**13.1%**	**13.2%**	**13.2%**	
Hour Ending	LPS 1 in 60 SB	LPS 2 in 41 EB off	LPS 3 in 70 EB	LPS 4 in 10 NB	LPS 5 in 80 WB	LPS 6 in 43 WB off	Total IN
1:00 AM	5	10	5	5	8	5	38
2:00 AM	2	8	4	2	2	2	20
3:00 AM	3	5	2	2	3	3	18
4:00 AM	3	7	3	3	4	2	22
5:00 AM	8	11	3	6	7	10	45
6:00 AM	28	22	14	19	23	20	126
7:00 AM	51	41	45	36	53	27	253
8:00 AM	64	52	65	49	58	25	313
9:00 AM	42	51	53	33	48	18	245
10:00 AM	35	45	46	31	39	20	216
11:00 AM	33	42	47	29	40	20	211
12:00 PM	31	49	48	29	41	21	219
1:00 PM	33	51	58	31	44	18	235
2:00 PM	34	54	65	32	45	23	253
3:00 PM	43	69	67	35	46	23	283
4:00 PM	43	92	79	35	44	21	314
5:00 PM	42	117	91	37	49	22	358
6:00 PM	45	122	96	40	37	25	365
7:00 PM	32	79	69	30	40	14	264
8:00 PM	26	51	45	22	29	13	186
9:00 PM	21	38	41	16	21	15	152
10:00 PM	14	36	29	12	18	10	119
11:00 PM	11	22	12	8	10	11	74
12:00 AM	5	15	10	6	5	3	44
24-Hour	**654**	**1089**	**997**	**548**	**714**	**371**	**4373**
11:00a- 1:30p	81	127	139	76	108	51	581
LPS: 2.5Hr	**81**	**127**	**139**	**76**	**108**	**51**	**581**
% of 24-Hr	12.4%	11.7%	13.9%	13.9%	15.1%	13.7%	13.3%
Remain-19Hr	**573**	**962**	**858**	**472**	**606**	**320**	**3792**
% of 24-Hr	87.6%	88.3%	86.1%	86.1%	84.9%	86.3%	86.7%

Independent Calculation for Trucks :

Axle.Corr.Fact.	*0.834*	*0.838*	*0.838*	*0.842*	*0.838*	*0.838*
Pct.Trucks	*16.1%*	*15.7%*	*15.7%*	*15.3%*	*15.7%*	*15.7%*

Table A.23 : Calculation of 24-Hour Outbound Heavy Vehicles

Unadjusted INDOT Mechanical Vehicle Counts

Hour Ending	LPS A out 60 NB	LPS B out 44 WB on	LPS C out 70 WB	LPS D out 10 SB	LPS E out 80 EB	LPS F out 42 EB on	Total OUT
1:00 AM	53	94	28	41	37	64	317
2:00 AM	30	41	14	27	33	36	181
3:00 AM	19	41	18	22	13	23	136
4:00 AM	28	80	31	29	23	24	215
5:00 AM	35	164	73	46	20	49	387
6:00 AM	91	537	223	123	34	86	1094
7:00 AM	231	1187	417	230	165	142	2372
8:00 AM	370	1315	556	250	282	222	2995
9:00 AM	299	670	461	249	195	203	2077
10:00 AM	248	479	424	278	229	166	1824
11:00 AM	259	503	444	266	261	194	1927
12:00 PM	280	421	476	261	281	168	1887
1:00 PM	334	450	506	266	295	212	2063
2:00 PM	307	500	468	294	322	212	2103
3:00 PM	398	553	537	306	375	191	2360
4:00 PM	530	598	685	389	465	305	2972
5:00 PM	571	530	725	381	523	258	2988
6:00 PM	475	528	542	406	447	223	2621
7:00 PM	400	412	469	329	380	164	2154
8:00 PM	262	273	338	247	258	126	1504
9:00 PM	242	235	273	203	194	125	1272
10:00 PM	146	165	166	147	142	81	847
11:00 PM	76	144	104	85	90	65	564
12:00 AM	104	96	54	63	83	105	505
24-Hour	**5788**	**10016**	**8032**	**4938**	**5147**	**3444**	**37365**
11:00a- 1:30p	751	2837	1204	605	545	466	6406
	1311	1357	1610	982	1203	634	7095
LPS: 2.5Hr	**2062**	**4194**	**2814**	**1587**	**1748**	**1100**	**13501**
% of 24-Hr	35.6%	41.9%	35.0%	32.1%	34.0%	31.9%	36.1%
Remain-19Hr	**3726**	**5822**	**5218**	**3351**	**3399**	**2344**	**23864**
% of 24-Hr	64.4%	58.1%	65.0%	67.9%	66.0%	68.1%	63.9%

Axle Adjusted INDOT Mechanical Counts : Outbound Heavy Vehicles

Axle.Corr.Fact.		0.878	0.860	0.860	0.841	0.860	0.860	
Pct.Trucks		**12.9%**	**14.4%**	**14.4%**	**15.8%**	**14.4%**	**14.4%**	
Hour Ending		LPS A out 60 NB	LPS B out 44 WB on	LPS C out 70 WB	LPS D out 10 SB	LPS E out 80 EB	LPS F out 42 EB on	Total OUT
1:00 AM		6	12	3	5	5	8	39
2:00 AM		3	5	2	4	4	4	22
3:00 AM		2	5	2	3	2	3	17
4:00 AM		3	10	4	4	3	3	27
5:00 AM		4	20	9	6	2	6	47
6:00 AM		10	67	28	16	4	11	136
7:00 AM		26	147	52	31	20	18	294
8:00 AM		42	163	69	33	35	27	369
9:00 AM		34	83	57	33	24	25	256
10:00 AM		28	59	53	37	28	21	226
11:00 AM		29	62	55	35	32	24	237
12:00 PM		32	52	59	35	35	21	234
1:00 PM		38	56	63	35	37	26	255
2:00 PM		35	62	58	39	40	26	260
3:00 PM		45	68	67	41	46	24	291
4:00 PM		60	74	85	52	58	38	367
5:00 PM		65	66	90	51	65	32	369
6:00 PM		54	65	67	54	55	28	323
7:00 PM		45	51	58	44	47	20	265
8:00 PM		30	34	42	33	32	16	187
9:00 PM		27	29	34	27	24	15	156
10:00 PM		17	20	21	20	18	10	106
11:00 PM		9	18	13	11	11	8	70
12:00 AM		12	12	7	8	10	13	62
24-Hour		**656**	**1240**	**998**	**657**	**637**	**427**	**4615**
11:00a- 1:30p		88	139	151	90	92	60	619
LPS: 2.5Hr		**88**	**139**	**151**	**90**	**92**	**60**	**619**
% of 24-Hr		13.4%	11.2%	15.1%	13.7%	14.4%	14.1%	13.4%
Remain-19Hr		**568**	**1101**	**847**	**567**	**545**	**367**	**3996**
% of 24-Hr		86.6%	88.8%	84.9%	86.3%	85.6%	85.9%	86.6%

Independent Calculation for Trucks :

Axle.Corr.Fact.	*0.849*	*0.837*	*0.837*	*0.824*	*0.837*	*0.837*	
Pct.Trucks	*18.1%*	*18.2%*	*18.2%*	*18.3%*	*18.2%*	*18.2%*	

Expansion of Through Trip Matrices Using 24-Hour Vehicle Estimates

The final procedure in the estimation of daily through trips is the expansion of the through trip matrices [Tables A.05 and A.08] from AM, PM and Mid-Day survey period to full 24-hour weekday matrices. This procedure employs the patterns of through trip distribution established separately for passenger vehicles and heavy vehicles and uses the relationships between through trip volumes and total trip volumes to guide the expansion calculations.

Because through trips made by passenger vehicles and heavy vehicle were shown to exhibit different distribution patterns, it is necessary to calculate the 24-hour through trip matrices separately by vehicle type. These matrices can then be added together for estimated total through trip distribution.

The final adjusted through trip values calculated in Tables A.18 and A.19 were applied to the preliminary through trip matrices shown in Tables A.05 and A.08. [The mechanics of this expansion are the same as those described in detail for Tables A.04 and A.05.] After this adjustment, the 2.5-hour AM and PM passenger vehicle matrices were added together to give a 5-hour passenger vehicle through trip matriA. Completion of the expansion procedure will be described in detail for passenger vehicles using examples from Table A.24.

The procedure for heavy vehicle expansion is identical, except for the use of 2.5-hour sample data for the structure of the matriA. Table A.25 shows the spreadsheet calculations for daily heavy vehicle through trips.

The 5-hour passenger vehicle through trip matrix was expanded to 24-hours by a series of spreadsheet calculations shown in Table A.24. Row and column totals of the 5-hour through trip matrix represent the total number of through trips passing through inbound [1–6] and outbound [A–F]; there are 1149 inbound trips and 1149 outbound trips. 5-hour total passenger vehicles at each station are take from Tables A.20 [inbound] and A.21 [outbound]. Percentages associated with the 5-hour matrix are total through passenger vehicles divided by total passenger vehicles at each station. Subject to slight rounding differences, the expansion procedure will hold these percentages constant.

The 24-hour passenger vehicle through trip matrix, shown in the lower half of Table A.24, uses the cell values, totals, and reference data from the 5-hour matriA. Row and column expanded control totals equal the corresponding [Percentage] of 5-Hour Passenger Vehicles multiplied by [Adjusted 24-Hour Total Passenger Vehicles]; for example :

Row 1 : 738 = 17.3% x 4269

Summed row and column control totals equal 3179 total inbound trips and 3182 outbound trips.

Adjusted 24-Hour Total Passenger Vehicle values are taken from Tables A.20 [inbound] and A.21 [outbound].

Each 24-hour cell value equals the average of two calculations. The corresponding 5-hour cell divided by its row total and multiplied by the 24-hour cell's row expanded control total and the 5-hour cell divided by its column total and multiplied by the 24-hour cell's column expanded control total; for example :

B1, Row 1 : (180 / 276) x 738 = 481
B1, Col B : (180 / 282) x 673 = 430
B1 in 24-hour matrix = average of (481, 430) = 455

After all 24-hour cells are thus calculated, the resulting matrix retains the proportional relationship to 24-hour total inbound and outbound passenger vehicles as exhibited by the 5-hour survey sample. Summed row and column totals equal 3183 inbound and 3183 outbound trips. These row and column sums, or 24-Hour Through Passenger Vehicles, when divided by row or column 24-Hour Total Passenger Vehicles, yield equivalent percentages to the corresponding calculation of 5-hour volumes; for example :

Row 1, 24-Hour : (730 / 4269) = 17.1%
Row 1, 5-Hour : (276 / 1597) = 17.3% [check];

Column B, 24-Hour : (722 / 5912) = 9.8%
Column B, 5-Hour : (282 / 3088) = 9.1% [check].

The outermost band of calculations in the 24-hour passenger vehicle matrix shows 24-Hour Total Vehicles – both passenger and heavy – at each station. Percentages expressed are 24-Hour Through Passenger Vehicles divided by 24-hour Total Vehicles; for example :

Row 1 = Station 1 : 4269 [Table A.20] + 654 [Table A.22] = 4923
730 / 4923 = 14.8%

Col A = Station A : 4428 [Table A.21] + 656 [Table A.23] = 5084;
1094 / 5084 = 21.5%

The same 24-hour Total Vehicle values are similarly used to derive the same statistical measure for each station in the heavy vehicle through trip matriA.

Table A.24 : Derivation of Daily Passenger Vehicle Through Trips

5-Hour Through Passenger Vehicle Trip Matrix

	A	B	C	D	E	F	Total		Adjusted 5-Hr Tot. Pass.Veh.		Pct.of 5-Hr Pass.Veh.
1		180	23	41	9	23	**276**		*1597*		*17.3%*
2	227		18	25	29		**299**		*2652*		*11.3%*
3	23	16		16	121	8	**184**		*2381*		*7.7%*
4	90	44	18		11	11	**174**		*1301*		*13.4%*
5	18	42	96	12		3	**171**		*1603*		*10.7%*
6	34		7	2	2		**45**		*776*		*5.8%*
Total	**392**	**282**	**162**	**96**	**172**	**45**		**1149**		*10310*	
							1149				
Adjusted 5-Hr Total Pass.Veh.	*1578*	*3088*	*2071*	*1123*	*1286*	*810*					
							9956				
Pct.of 5-Hr Pass.Veh.	*24.8%*	*9.1%*	*7.8%*	*8.5%*	*13.4%*	*5.6%*					

24-Hour Through Passenger Vehicle Trip Matrix

	A	B	C	D	E	F	Expanded Control Total		Adjusted 24-Hr Tot. Pass.Veh.		24-Hr Through Pass.Veh.	Pct.of 24-Hr Pass.Veh.	Adjusted 24-Hr Total.Veh.	Pct.of 24-Hr Tot.Veh.
1		455	64	119	25	67	738		*4269*		**730**	*17.1%*	4923	*14.8%*
2	625		50	73	82		807		*7159*		**830**	*11.6%*	8248	*10.1%*
3	64	41		47	344	24	505		*6539*		**520**	*8.0%*	7536	*6.9%*
4	252	114	51		32	33	486		*3634*		**482**	*13.3%*	4182	*11.5%*
5	52	112	278	36		9	502		*4702*		**487**	*10.4%*	5416	*9.0%*
6	101		21	6	6		141		*2423*		**134**	*5.5%*	2794	*4.8%*
Expanded Control Total	1100	673	462	299	507	141		3179		*28726*		**3183**		33099
							3182							
Adjusted 24-Hr Total Pass.Veh.	*4428*	*7372*	*5912*	*3497*	*3790*	*2537*								
							27536							
24-Hr Through Passenger.Veh.	**1094**	**722**	**464**	**281**	**489**	**133**								
Pct.of 24-Hr Pass.Veh.	*24.7%*	*9.8%*	*7.8%*	*8.0%*	*12.9%*	*5.2%*	**3183**							
Adjusted 24-Hr Total .Veh.	5084	8612	6910	4154	4427	2964								
Pct.of 24-Hr Total.Veh.	*21.5%*	*8.4%*	*6.7%*	*6.8%*	*11.0%*	*4.5%*	32151							

Table A.25 : Derivation of Daily Heavy Vehicle Through Trips

2.5-Hour Mid-Day Through Heavy Vehicle Trip Matrix

	A	B	C	D	E	F	Total		Adjusted 2.5-Hr Tot. Heavy Veh.		Pct.of 2.5-Hr Heavy Veh.
1		6	1	16	0	1	**24**		*81*		29.6%
2	8		4	3	6		**21**		*127*		16.5%
3	2	1		2	1	0	**6**		*139*		4.3%
4	21	4	1		3	2	**31**		*76*		40.8%
5	4	5	9	5		0	**23**		*108*		21.3%
6	7		0	11	0		**18**		*51*		35.3%
Total	**42**	**16**	**15**	**37**	**10**	**3**		123		*582*	
							123				
Adjusted 2.5-Hr Total Heavy Veh.	*88*	*139*	*151*	*90*	*92*	*60*					
							620				
Pct.of 2.5-Hr Heavy Veh.	47.7%	11.5%	9.9%	41.1%	10.9%	5.0%					

24-Hour Through Heavy Vehicle Trip Matrix

	A	B	C	D	E	F	Expanded Control Total		Adjusted 24-Hr Total Heavy Veh.		24-Hr Through Heavy Veh.	Pct.of 24-Hr Heavy Veh	Adjusted 24-Hr Total Veh.	Pct.of 24-Hr Total Veh
1		51	7	123	0	8	194		*654*		**189**	*28.9%*	4923	*3.8%*
2	64		30	24	46		180		*1089*		**164**	*15.1%*	8248	*2.0%*
3	15	8		14	7	0	43		*997*		**44**	*4.4%*	7536	*0.6%*
4	154	32	7		21	14	224		*548*		**228**	*41.6%*	4182	*5.5%*
5	28	39	59	35		0	152		*714*		**161**	*22.5%*	5416	*3.0%*
6	52		0	80	0		131		*371*		**132**	*35.6%*	2794	*4.7%*
Expanded Control Total	313	143	99	270	69	21		924		*4373*		**918**		33099
							915							
Adjusted 24-Hr Total Heavy Veh.	*656*	*1240*	*998*	*657*	*637*	*427*								
							4615							
24-Hr Through Heavy Veh.	**313**	**130**	**103**	**276**	**74**	**22**								
Pct.of 24-Hr Heavy Veh.	*47.7%*	*10.5%*	*10.3%*	*42.0%*	*11.6%*	*5.2%*	**918**							
Adjusted 24-Hr Total Veh.	5084	8612	6910	4154	4427	2964								
Pct.of 24-Hr Total Veh.	*6.2%*	*1.5%*	*1.5%*	*6.6%*	*1.7%*	*0.7%*	32151							

Evaluation of Daily Through Trip Estimates

Estimates of daily through trips by two broad types, passenger and heavy vehicles, are combined in Table A.26 to show total daily through trips. Row and column sums for 4101 inbound and 4101 outbound daily through trips are also compared to the daily total vehicles at each station.

Examination of Table A.26 supports several observations about the characteristics of through trips using the SR 9 corridor. The heaviest volumes of through trips appear to move between I-70 west of Greenfield and SR 9 north of its interchange with I-70. Such trips impact only the northern fringe of Greenfield. The second heaviest volumes of through trips are those using SR 9 to traverse Greenfield between its northern and southern limits. All through trips using these two origin-destination combinations pass through the I-70 / SR 9 interchange and are primarily passenger vehicles.

A third, but less significant, volume of through trips cross Greenfield on US 40 between its western and eastern limits. On this origin-destination combination, the number of heavy vehicle through trips is nearly equal to the number of passenger vehicle through trips. Although these trips appear to be independent of through trip movements originating on I-70 or SR 9, they compete with the north-south through trips at the intersection of US 40 and SR 9.

The congestive impact of converging through trips at the intersection of US 40 and SR 9 and along the SR 9 corridor between the I-70 interchange and US 40 should be carefully considered. Special attention must also be given to the presumed volume of external-internal and internal-external trips using the SR 9 corridor. Although by definition these are not through trips, having either destination or origin at some location within Greenfield, such trips share the same routes carrying the heaviest volumes of through trips.

Comparison of the Daily Through Trip Matrix with the INDOT Sub-Area Analysis

The INDOT SR 9 External Travel Analysis was conducted as a sub-area analysis using the TransCAD statewide model. This analysis was prepared on July 27, 2000 using a year 1995 trip table and a base highway network for the U.S. Census-defined Greenfield Urban Area. A brief summary of the analysis is quoted :

> "... 1995 through trips assigned to SR 9 = 8468 x model under assignment factor of 1.19 results in 10,077 estimated through trips eligible for bypass (approximately 50% of travel on SR 9 in 1995). Of these 5,047 through trips are associated with I-70 and use the SR 9 interchange (5,047 x 1.19 = 6,006 or approximately 60% of the through trips)."

Table A.27 shows the matrix of through trips calculated for the SR 9 corridor study compared to the earlier INDOT estimates fitted to the same directional matrix structure.

There are six cells in the INDOT matrix corresponding to movements not modeled by the INDOT sub-area analysis.

There is a substantial difference between the two estimates. The INDOT estimate of 21,518 through trip movements must be reconciled against the 4,101 through trip movements found by expansion of the license plate survey. Plausible explanations for the apparent inconsistency are underscored by the differences in methodologies used to develop the two estimates.

Table A.26 : Estimated Daily Through Vehicle Trips

24-Hour Through Passenger Vehicle Trip Matrix

	A	B	C	D	E	F	Total Through Passenger Vehicles		24-Hr Total Vehicles	Pct.of 24-Hr Tot.Veh.
1		455	64	119	25	67	**730**		4923	*14.8%*
2	625		50	73	82		**830**		8248	*10.1%*
3	64	41		47	344	24	**520**		7536	*6.9%*
4	252	114	51		32	33	**482**		4182	*11.5%*
5	52	112	278	36		9	**487**		5416	*9.0%*
6	101		21	6	6		**134**		2794	*4.8%*
Total Through Passenger Vehicles	**1094**	**722**	**464**	**281**	**489**	**133**	**3183**	**3183**		
24-Hr Total Vehicles	5084	8612	6910	4154	4427	2964				
Pct.of 24-Hr Total Veh.	*21.5%*	*8.4%*	*6.7%*	*6.8%*	*11.0%*	*4.5%*				

24-Hour Through Heavy Vehicle Trip Matrix

	A	B	C	D	E	F	Total Through Heavy Vehicles		24-Hr Total Vehicles	Pct.of 24-Hr Tot.Veh.
1		51	7	123	0	8	**189**		4923	*3.8%*
2	64		30	24	46		**164**		8248	*2.0%*
3	15	8		14	7	0	**44**		7536	*0.6%*
4	154	32	7		21	14	**228**		4182	*5.5%*
5	28	39	59	35		0	**161**		5416	*3.0%*
6	52		0	80	0		**132**		2794	*4.7%*
Total Through Heavy Vehicles	**313**	**130**	**103**	**276**	**74**	**22**	**918**	**918**		
24-Hr Total Vehicles	5084	8612	6910	4154	4427	2964				
Pct.of 24-Hr Total Veh.	*6.2%*	*1.5%*	*1.5%*	*6.6%*	*1.7%*	*0.7%*				

24-Hour Total Through Trip Matrix

	A	B	C	D	E	F	Total Through Vehicles		24-Hr Total Vehicles	Pct.of 24-Hr Tot.Veh.
1		506	71	242	25	75	**919**		4923	*18.7%*
2	689		80	97	128		**994**		8248	*12.1%*
3	79	49		61	351	24	**564**		7536	*7.5%*
4	406	146	58		53	47	**710**		4182	*17.0%*
5	80	151	337	71		9	**648**		5416	*12.0%*
6	153		21	86	6		**266**		2794	*9.5%*
Total Through Vehicles	**1407**	**852**	**567**	**557**	**563**	**155**	**4101**	**4101**		
24-Hr Total Vehicles	5084	8612	6910	4154	4427	2964				
Pct.of 24-Hr Total Veh.	*27.7%*	*9.9%*	*8.2%*	*13.4%*	*12.7%*	*5.2%*				

Table A.27 : Comparison of Daily Through Trip Estimates : O-D Survey vs INDOT Analysis

24-Hour Total Through Trip Matrix

	A	B	C	D	E	F	Total Through Vehicles		24-Hr Total Vehicles	Pct.of 24-Hr Tot.Veh.
1		506	71	242	25	75	**919**		4923	*18.7%*
2	689		80	97	128		**994**		8248	*12.1%*
3	79	49		61	351	24	**564**		7536	*7.5%*
4	406	146	58		53	47	**710**		4182	*17.0%*
5	80	151	337	71		9	**648**		5416	*12.0%*
6	153		21	86	6		**266**		2794	*9.5%*
Total Through Vehicles	**1407**	**852**	**567**	**557**	**563**	**155**	**4101**	**4101**		
24-Hr Total Vehicles	5084	8612	6910	4154	4427	2964				
Pct.of 24-Hr Total Veh.	*27.7%*	*9.9%*	*8.2%*	*13.4%*	*12.7%*	*5.2%*				

24-Hour Total Through Trip Matrix [INDOT Model Subarea]

	A	B	C	D	E	F	Total Through Vehicles		24-Hr Total Vehicles	Pct.of 24-Hr Tot.Veh.
1		1323	140	1538	89		**3090**		4923	62.8%
2	1435			474	773		**2682**		8248	32.5%
3	59			277	5037	169	**5542**		7536	73.5%
4	1409	711	513		460	196	**3289**		4182	78.6%
5	186	2041	3348	657			**6232**		5416	115.1%
6			375	308			**683**		2794	24.4%
	3089	**4075**	**4376**	**3254**	**6359**	**365**	21518	21518		
24-Hr.Total	5084	8612	6910	4154	4427	2964				
	60.8%	47.3%	63.3%	78.3%	143.6%	12.3%				

The PKG/PIC O-D survey counted and expanded a finite number of through trips strictly constrained by identification and station to station travel time parameters. Therefore, although based on a sampling technique, this estimate is biased toward the minimum number of actual weekday through trips.

The INDOT estimate is based on a mathematical model using a road network suitable for statewide analysis. Adapting the relatively low density of the statewide road network to a small geographic sub-area tends to force multiple all-or-nothing travel assignments to the limited number of physical links. This means that numerous trips that would physically use dispersed county or local roads are concentrated by the model onto the SR 9 and US 40 roadway links. Furthermore, the distinctions between through trips and near through trips (actually external-internal and internal-external trips) are much more difficult to quantify at the geographic resolution of the statewide model in a county exhibiting rural characteristics, such as those surrounding the Greenfield urban area. Therefore, the INDOT estimate should be viewed as biased toward a maximize number of potential weekday through trips.

Table A.28 is intended to complete the reconciliation between the two estimates by illustrating the numeric relationships between the individual cells in each matrix and by comparing these relationships against each other.

Matrix [A] shows the percentage of each cell to the sum of through trips in the matrix based on expansion of the license plate survey and mechanical vehicle counts. Row (inbound) and column (outbound) averages are displayed and also compared to the 4.1% overall average for the entire matriA. Note that the six through trip movements not modeled by the INDOT analysis are excluded from the survey matrix to enable direct comparisons.

Table A.28 : Statistical Comparison of O-D Survey and INDOT Analysis Through Trip Results

[A] Compared Relative Percentages [License Plate Survey]

	A	B	C	D	E	F	Inbound Row Average		24-Hr Overall Average	Inbound Pct.of Overall	
1		12.3%	1.7%	5.9%	0.6%		**5.1%**		4.1%	124.5%	
2	16.8%			2.4%	3.1%		**7.4%**		4.1%	179.7%	
3	1.9%			1.5%	8.6%	0.6%	**3.1%**		4.1%	76.0%	
4	9.9%	3.6%	1.4%		1.3%	1.1%	**3.5%**		4.1%	83.8%	
5	2.0%	3.7%	8.2%	1.7%			**3.9%**		4.1%	94.2%	
6			0.5%	2.1%			**1.3%**		4.1%	31.6%	
Outbound Col Average	**7.6%**	**6.5%**	**3.0%**	**2.7%**	**3.4%**	**0.9%**	4.0%	4.1%			98.3%
24-Hr Overall Average	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%					
Outbound Pct.of Overall	185.0%	157.9%	71.8%	65.7%	82.2%	20.9%	97.3%				

[B] Compared Relative Percentages [INDOT Model Subarea]

	A	B	C	D	E	F	Inbound Row Average		24-Hr Overall Average	Inbound Pct.of Overall	
1		6.1%	0.7%	7.1%	0.4%		**3.6%**		4.5%	79.0%	
2	6.7%			2.2%	3.6%		**4.2%**		4.5%	91.4%	
3	0.3%			1.3%	23.4%	0.8%	**6.4%**		4.5%	141.7%	
4	6.5%	3.3%	2.4%		2.1%	0.9%	**3.1%**		4.5%	67.3%	
5	0.9%	9.5%	15.6%	3.1%			**7.2%**		4.5%	159.3%	
6			1.7%	1.4%			**1.6%**		4.5%	34.9%	
Outbound Col Average	**3.6%**	**6.3%**	**5.1%**	**3.0%**	**7.4%**	**0.8%**	4.4%	4.3%			95.6%
24-Hr Overall Average	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%					
Outbound Pct.of Overall	79.0%	138.9%	111.9%	66.5%	162.5%	18.7%	96.2%				

[A] / [B] Ratio of Percentage Comparisons

		A	B	C	D	E	F	Inbound Row Average		24-Hr Overall Average	Inbound Pct.of Overall	
=> 2.13	1		2.01	2.66	0.83	1.47		**1.74**		1.42	122.6%	
	2	2.52			1.07	0.87		**1.49**		1.42	104.7%	
=< 0.71	3	7.03			1.16	0.37	0.75	**2.32**		1.42	163.5%	
	4	1.51	1.08	0.59		0.60	1.26	**1.01**		1.42	71.0%	
	5	2.26	0.39	0.53	0.57			**0.94**		1.42	65.8%	
	6			0.29	1.47			**0.88**		1.42	61.9%	
Outbound Col Average		**3.33**	**1.16**	**1.02**	**1.02**	**0.83**	**1.00**	1.39	1.40			98.2%
24-Hr Overall Average		1.42	1.42	1.42	1.42	1.42	1.42					
Outbound Pct.of Overall		234.2%	81.4%	71.7%	71.6%	58.3%	70.5%	98.0%				

Matrix [B] presents the same cell and matrix statistics for through trips developed by the INDOT sub-area analysis. Row (inbound) and column (outbound) averages are displayed and also compared to the 4.5% overall average for the entire matriA.

Numeric differences between matrix [A] and matrix [B] are presented in the third matrix by expressing the differences as the ratio of [A] values divided by corresponding [B] values. This calculation reveals a relative similarity between [A] and [B] values when the magnitude of variance between individual cell ratios and the overall [A]/[B] ratio of 1.42 is evaluated.

Four cells, or 18% of twenty-two cells in the matrix, are equal or greater than 2.13 [1.42 + 50% x (1.42)]. Seven (7) cells, or 32% of the cells in the matrix are equal or less than 0.71 [1.42 – 50% x (1.42)]. The remaining eleven (11) cells, or 50%, are within plus or minus half the value of the overall ratio of 1.42. Furthermore, cells exhibiting the greatest variance correspond to matrix [A] or matrix [B] cells with small values.

Table A.28 supports the contention that while there are substantial differences in overall through trip *volumes*, as developed by the two different methodologies, there is an equally substantial similarity in the *distribution* of through trips regardless of method. This conclusion suggests that the magnitude of through trips using the SR 9 corridor are probably in the intermediate range between the PKG/PIC survey values and those generated by the INDOT sub-area analysis.

Accordingly, volumes and distribution of through trips must be carefully weighed when the conflict between through trips and external-internal trip ends is incorporated into the justification analysis for a SR 9 bypass in the vicinity of Greenfield.